High Resolution Stereo Satellite Elevation Mapping Service
Confirmed Proof of Accuracy
Case History, WorldView-1 Stereo Photos, Asmara, Eritrea

A one-metre square grid of elevations was produced by geophysical processing of WorldView-1 stereo satellite photos over an area of 374 square kilometres.

The elevation accuracy is better than 35cm RMSE for areas up to 10km by 10km as determined by over 15,000 conventionally established elevation checkpoints.

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Kevin MacNabb, Geophysicist, President MWH Geo-Surveys Inc.

A 1m square grid of elevation values, covering an area of 374 square kilometres, was produced for the Asmara Project of Sunridge Gold in Eritrea (TSX.V:SGC). The elevation grid was constructed using geophysical processing of 50cm ground resolution stereo satellite photos taken by the Digital Globe WorldView-1 satellite. The stereo satellite elevations were referenced to the same benchmark as over 15,000 previously established accurately surveyed gravity survey stations.

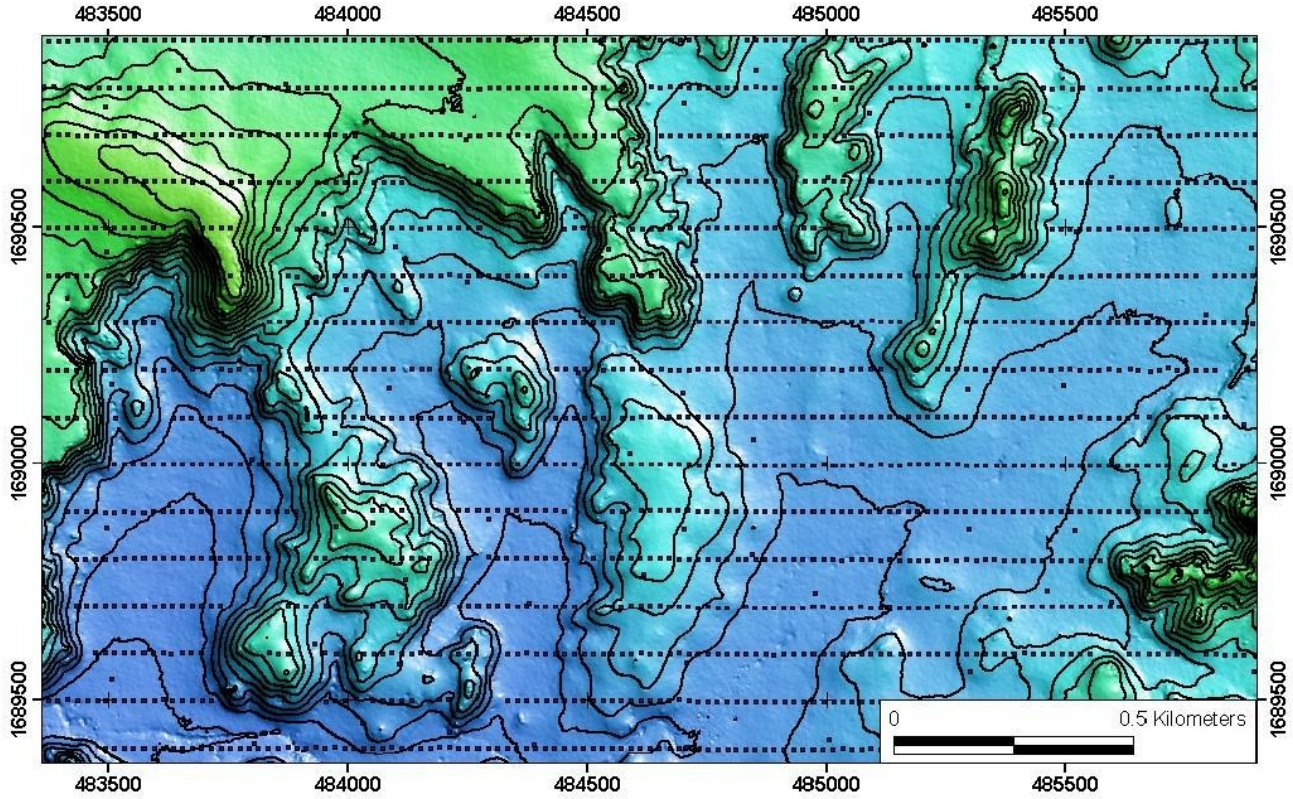

Figure 1. Stereo satellite elevation map with 5m contours showing some of the 15,020 checkpoints used to determine the elevation mapping accuracy of better than 35cm Root Mean Square Error (RMSE) for areas up to 10km by 10km for the WorldView-1 stereo photos on the Sunridge Gold Asmara Project. For more information about the Sunridge Gold Asmara Project, please consult the Sunridge Gold website: www.Sunridgegold.com/s/Asmara.asp

Figure 2. Asmara Project, Eritrea. MWH Geo-Surveys differential GPS survey crew and equipment. Over 45,000 gravity stations were surveyed from 2004 through 2008 using differential GPS instruments from Magellan. All of the GPS positions were surveyed in Real Time Kinematic (RTK) mode with accuracies of 2cm or better. 15,020 of these gravity survey stations were used as elevation checkpoints for the WorldView-1 stereo satellite elevation mapping accuracy assessment. The Magellan RTK base with a ProMark™ 500 GPS rover are shown in this photo.

Figure 3. The entire 374 square kilometre Asmara, Eritrea WorldView-1 stereo satellite elevation mapping project was tied to the single ground control point shown in this photo. The accuracy of the stereo satellite elevation mapping of better than 35cm RMSE for areas up to 10km by 10km was determined using 15,020 independent elevation checkpoints.

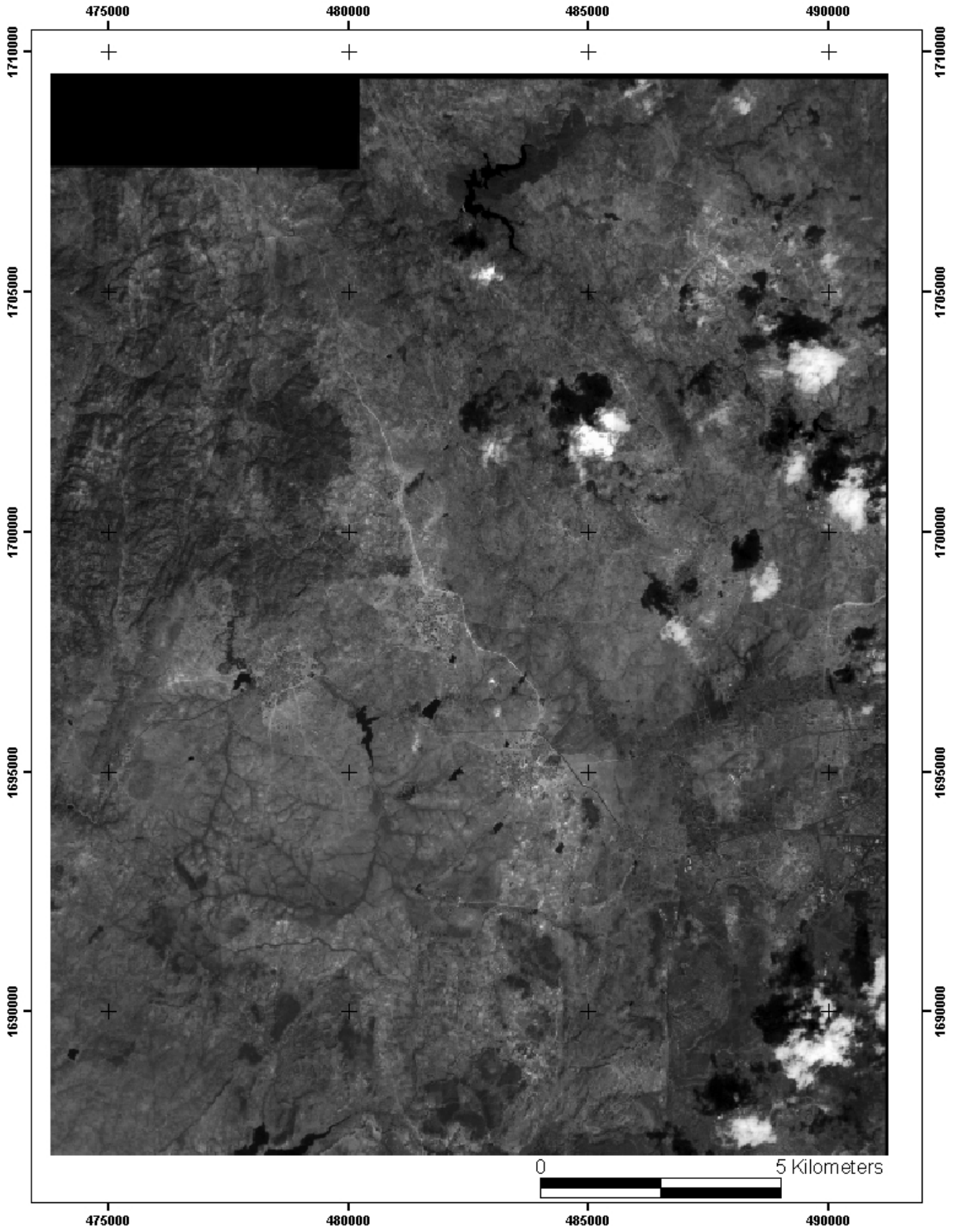

Figure 4. WorldView-1 50cm stereo photo. Asmara, Eritrea.

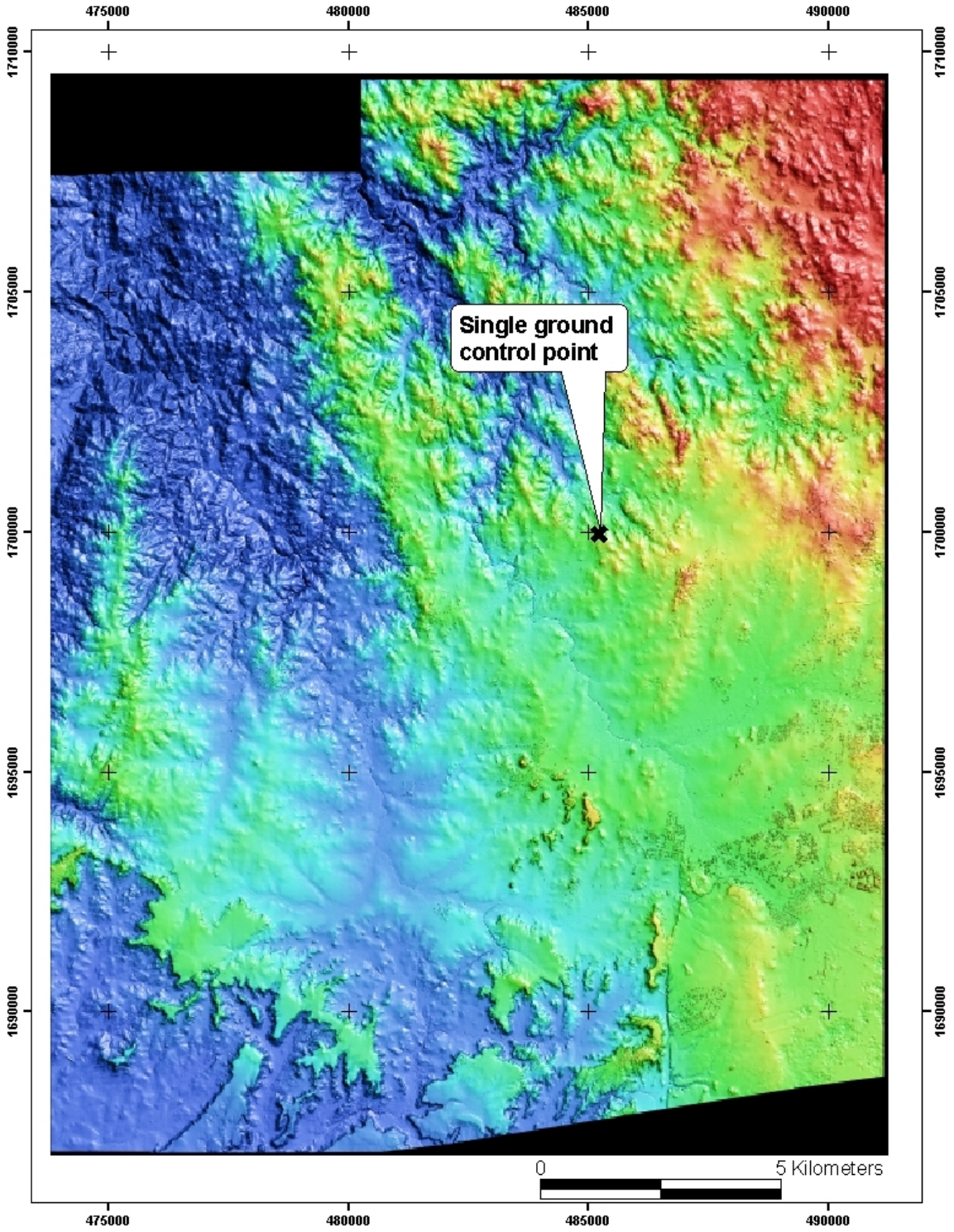

Figure 5. Stereo WorldView-1 elevation image created from a 1m posted DEM. Asmara, Eritrea.

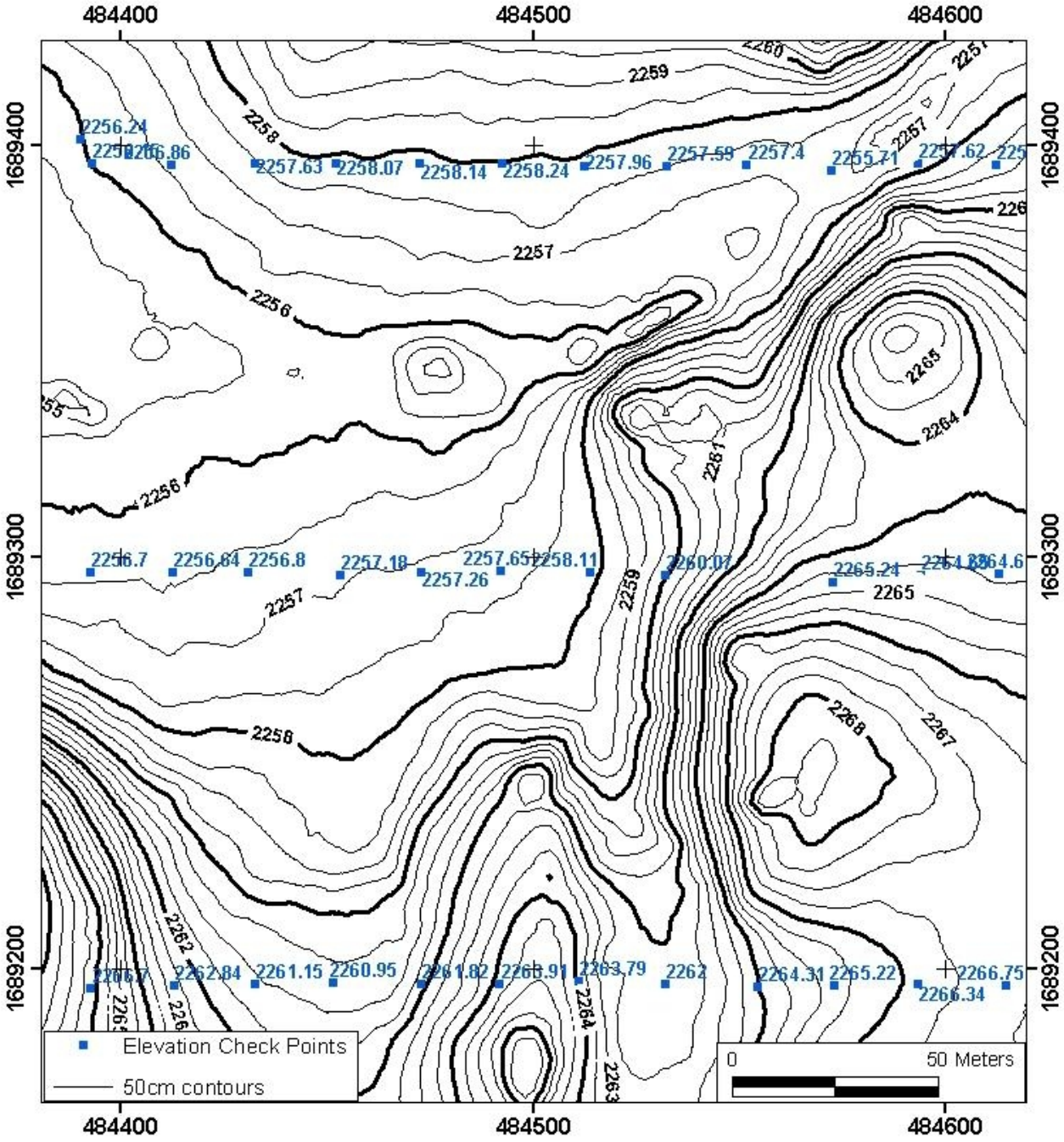

Figure 6. 50cm contours from the stereo WorldView-1 elevation mapping showing the elevations of some of the 15,020 elevation checkpoints used to determine the stereo satellite elevation mapping accuracy of better than 35cm RMSE for areas up to 10km by 10km.

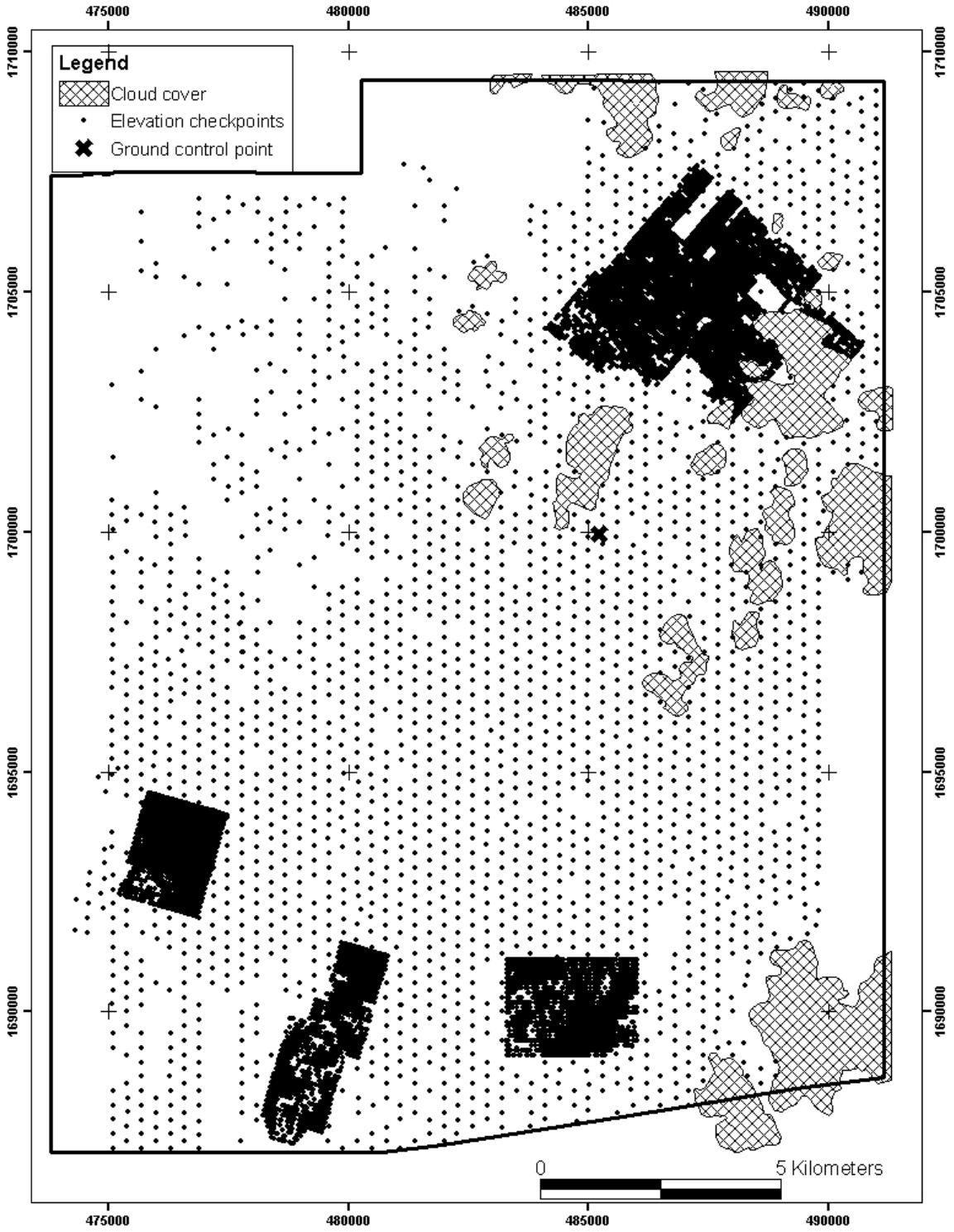

Figure 7. Area of the 22km by 17km Eritrea Stereo WorldView-1 1m posted DEM showing the single ground control point and the 15,020 gravity survey stations used as elevation checkpoints to determine the accuracy of the stereo satellite elevation mapping. As recommended in the *Guidelines for Digital Elevation Data* of the US National Digital Elevation Program (NDEP), the elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

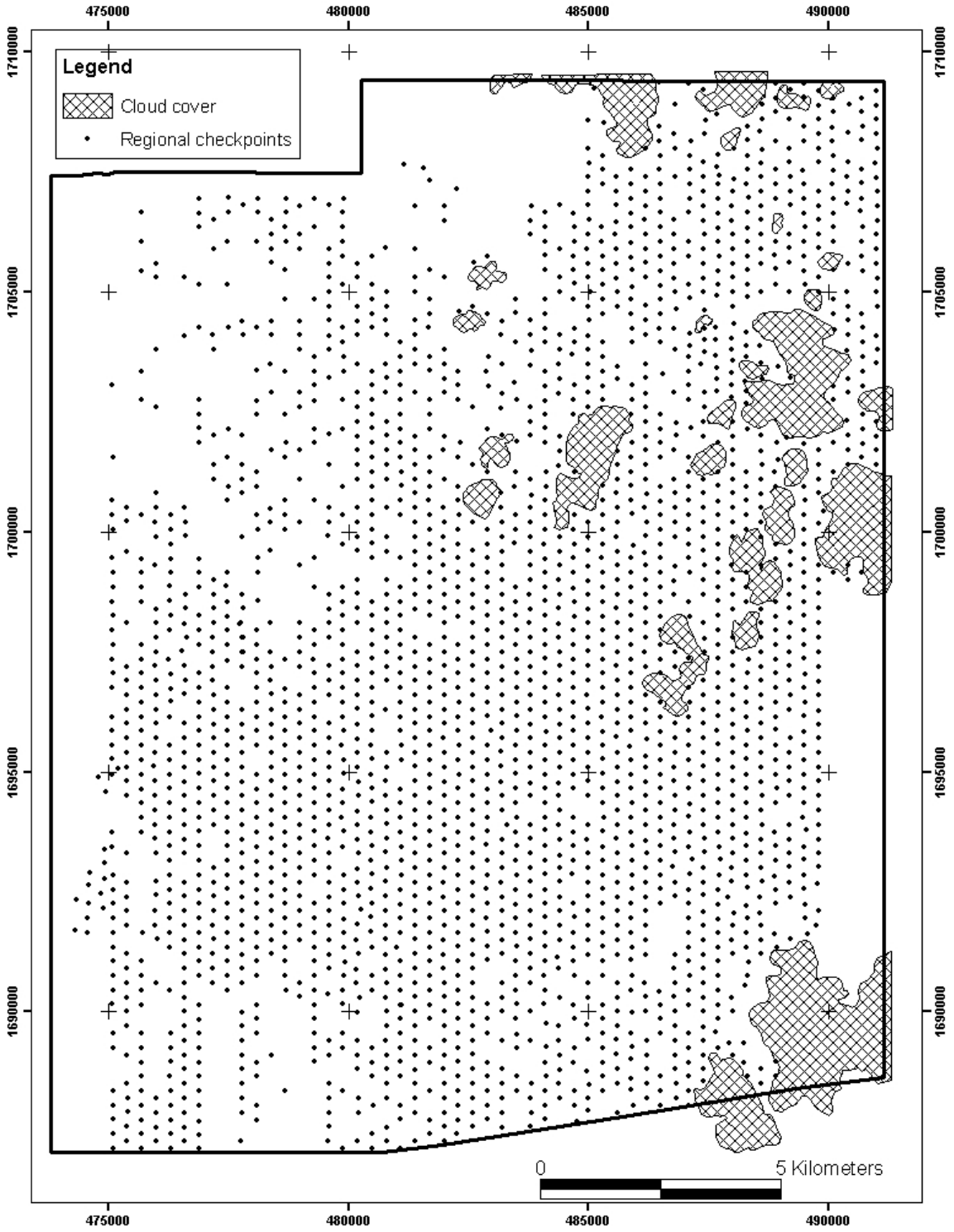

Figure 8. Area of the 22km by 17km Eritrea Stereo WorldView-1 1m posted DEM showing the 2,538 regional gravity survey stations, in a grid of approximately 250m by 350m, used as elevation checkpoints to determine the accuracy of the stereo satellite elevation mapping. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

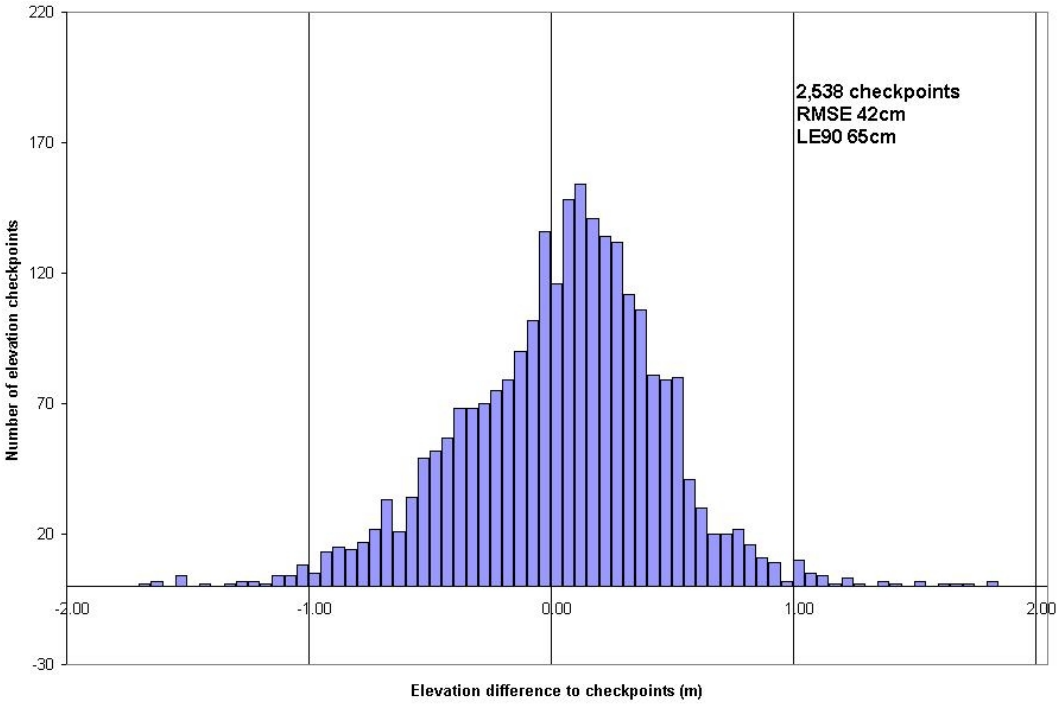

Figure 9. Histogram of the elevation differences between the WorldView-1 stereo satellite elevations for the 22km by 17km area and the 2,538 regional elevation checkpoints. The Root Mean Square Error (RMSE) is 42cm, and the Linear Error (LE90) is 65cm. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

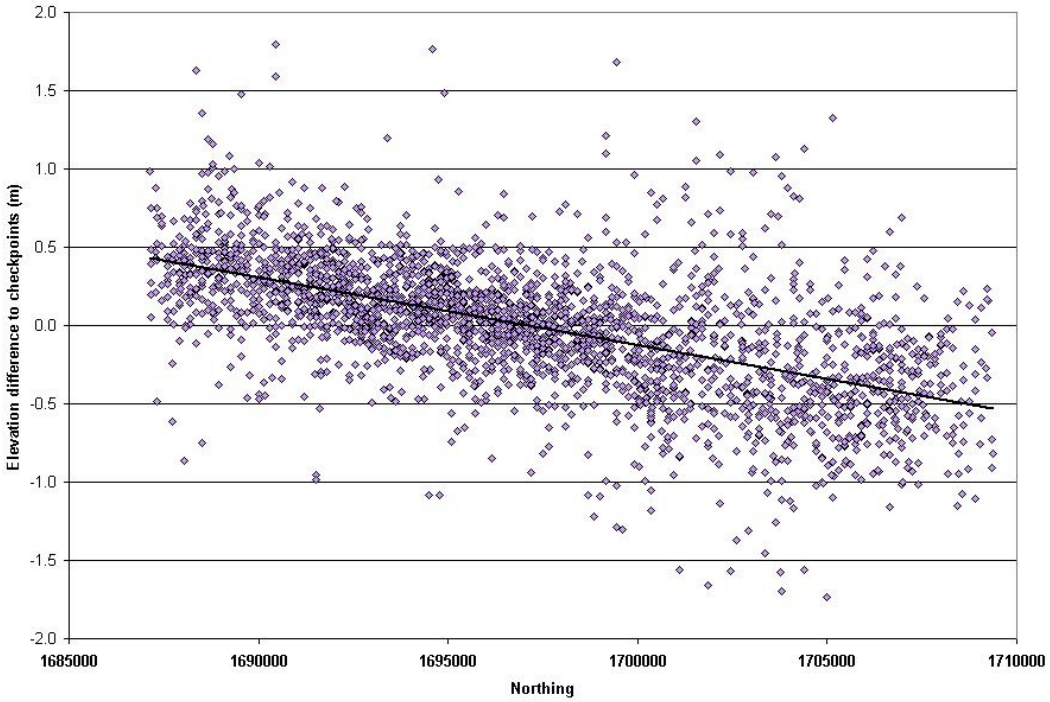

Figure 10. Plot of the elevation differences between the WorldView-1 stereo satellite elevations for the 22km by 17km area and the 2,538 regional elevation checkpoints as a function of Northing. The least squares regression line has a slope of -4.3cm/km.

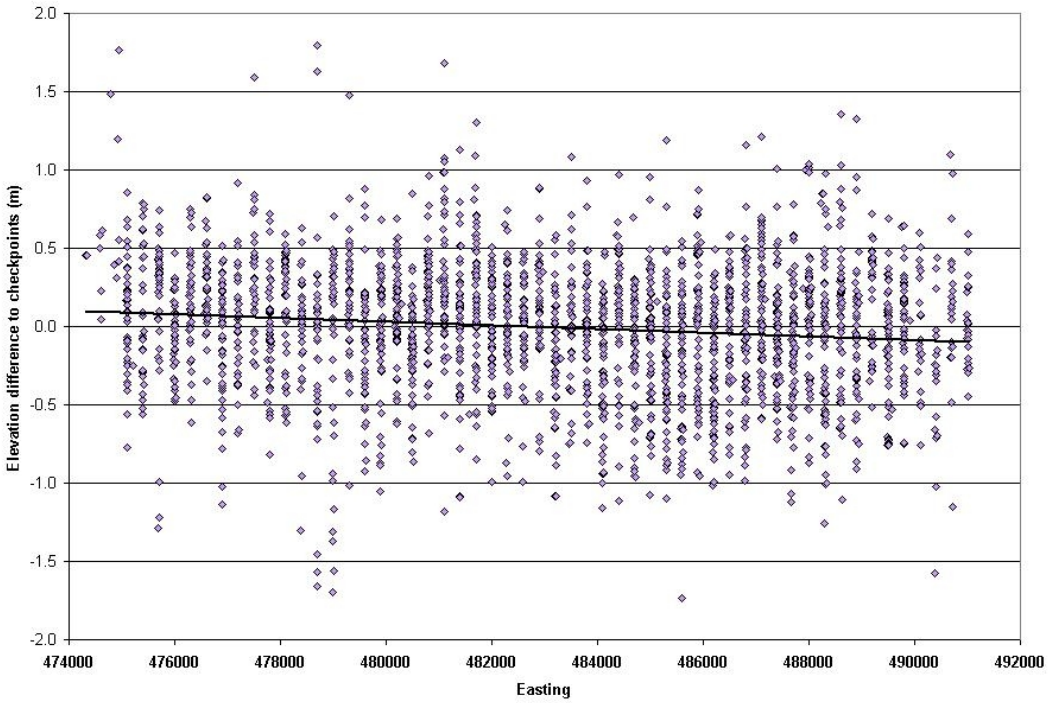

Figure 11. Plot of the elevation differences between the WorldView-1 stereo satellite elevations for the 22km by 17km area and the 2,538 regional elevation checkpoints as a function of Easting. The least squares regression line has a slope of -1.2cm/km.

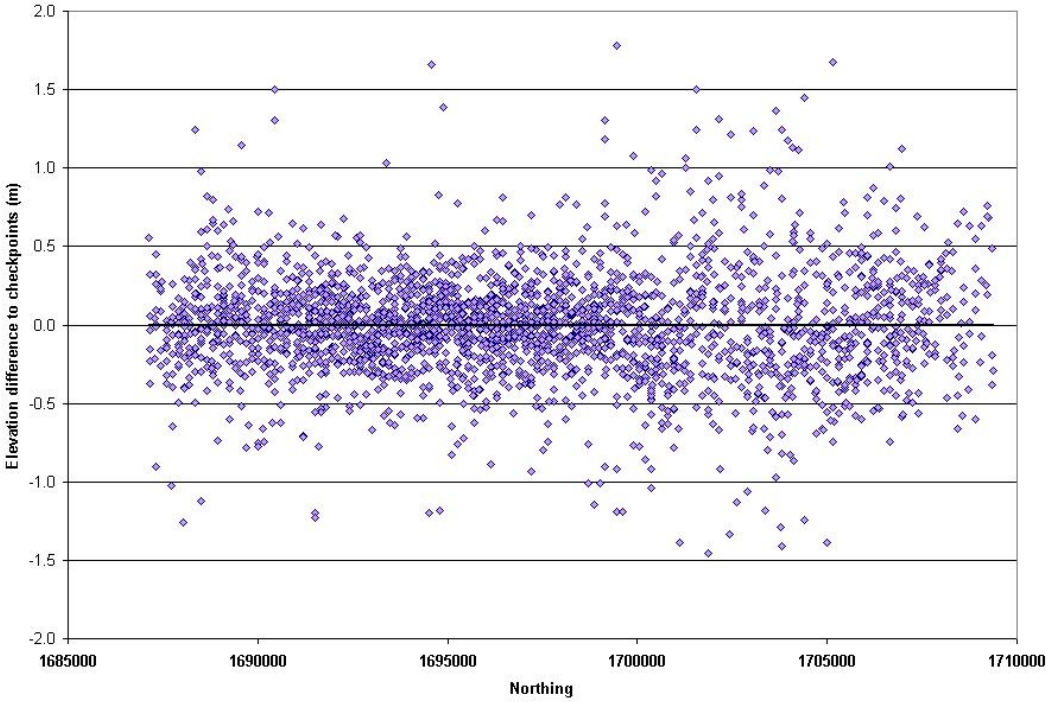

Figure 12. Plot of the elevation differences between the WorldView-1 stereo satellite elevations for the 22km by 17km area, adjusted by 4.3cm/km North-South, and the 2,538 regional elevation checkpoints as a function of Northing. This simulates the adjustment of the DEM to fit at least two perfect ground control points.

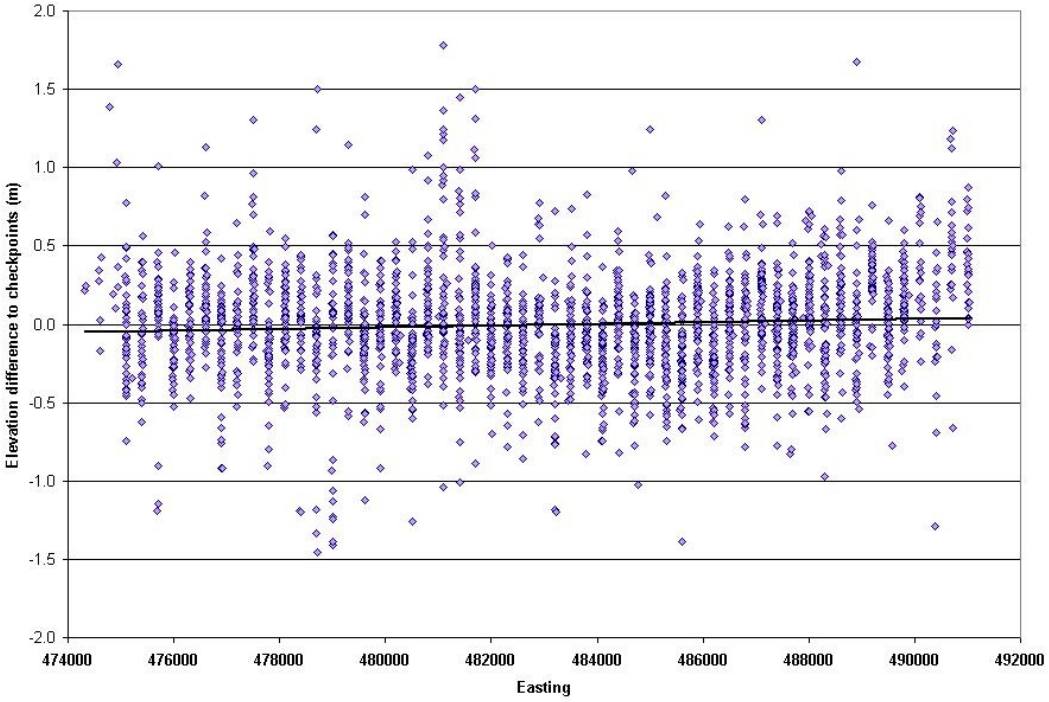

Figure 13. Plot of the elevation differences between the WorldView-1 stereo satellite elevations for the 22km by 17km area and the 2,538 regional elevation checkpoints as a function of Easting, after the North-South adjustment by 4.3cm/km. The least squares regression line has a slope of 0.5cm/km.

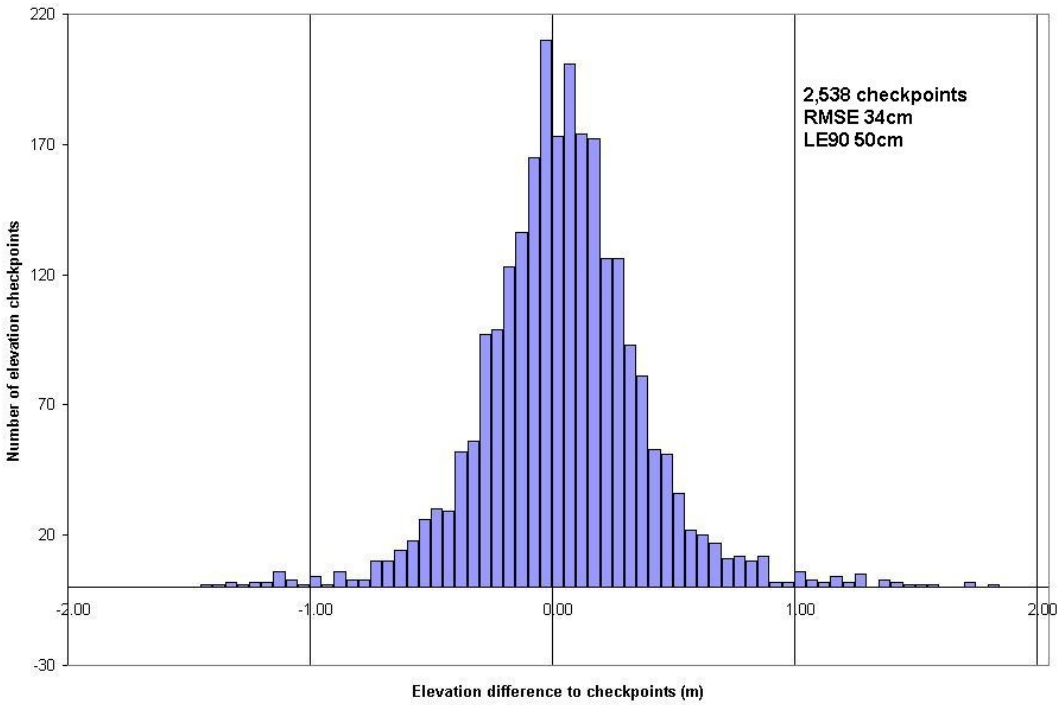

Figure 14. Histogram of the elevation differences between the WorldView-1 stereo satellite elevations for the 22km by 17km area and the 2,538 regional elevation checkpoints, after the North-South adjustment by 4.3cm/km. RMSE 34cm, LE90 50cm. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

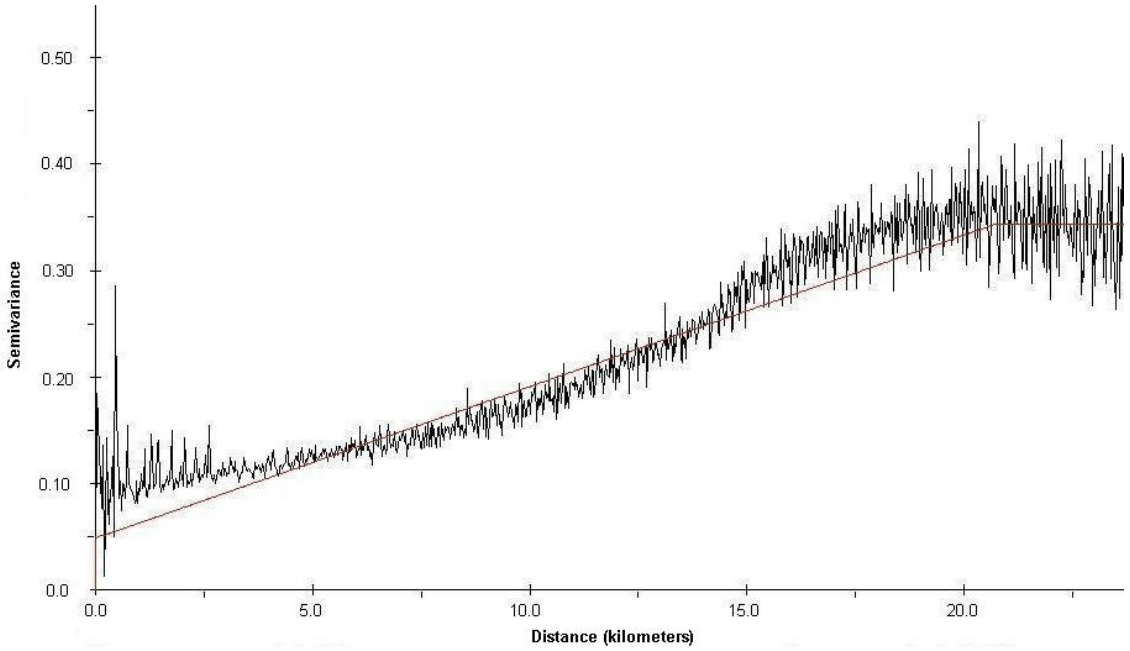

Figure 15. The semivariogram of the elevation differences between the WorldView-1 stereo satellite elevations and the 2,538 regional checkpoints in a 250m by 350m grid shows a very close correlation of the elevation differences out to a distance of 10km between elevation points.

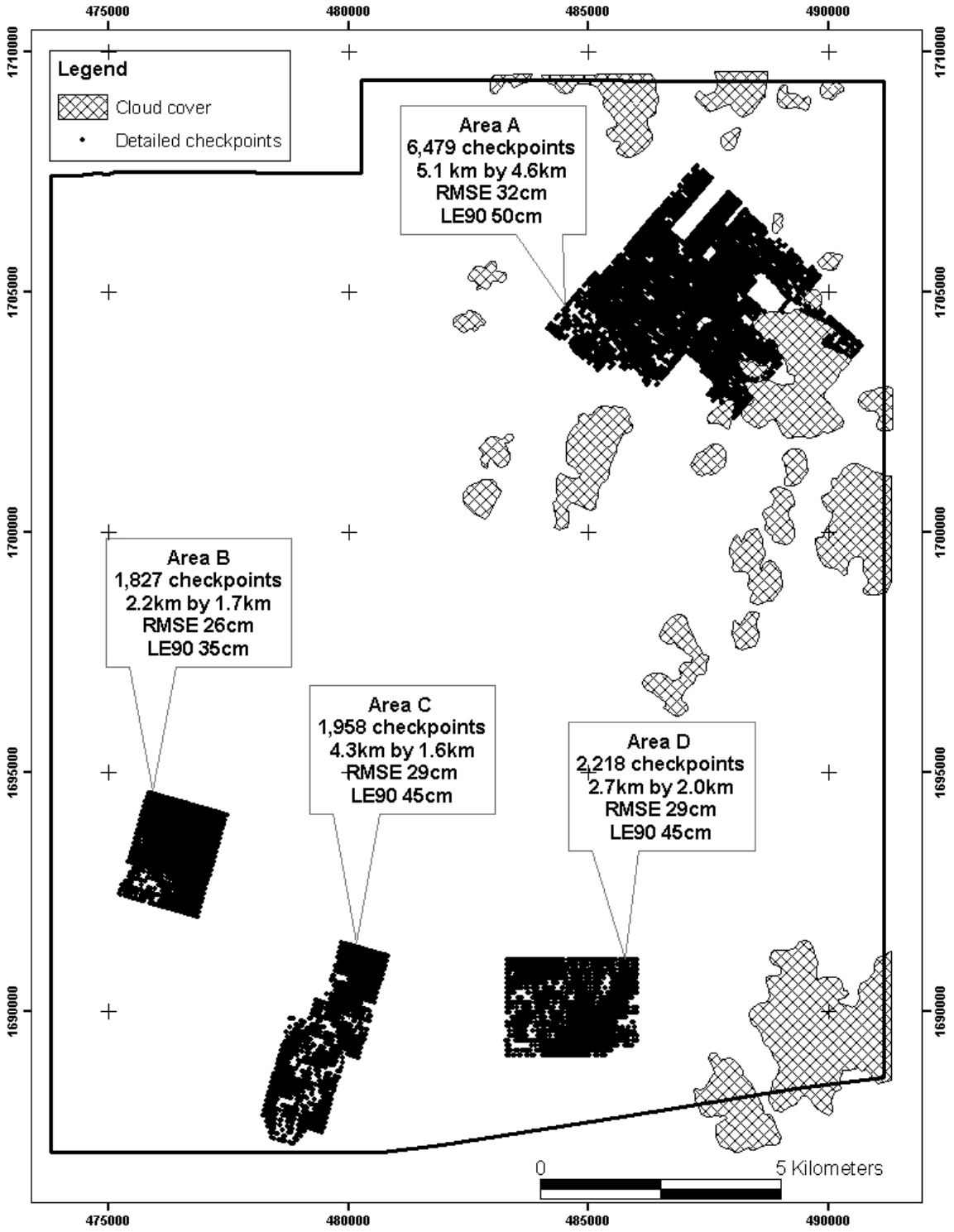

Figure 16. Areas with 20m by 100m grids of gravity survey stations used as elevation checkpoints to determine the accuracy of the stereo satellite elevation mapping. Area A has 6,479 checkpoints over an area of 5.1km by 4.6km, area B has 1,827 checkpoints over an area of 2.2km by 1.7km, area C has 1,958 checkpoints over an area of 4.3km by 1.6km, area D has 2,218 checkpoints over an area of 2.7km by 2.0km. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

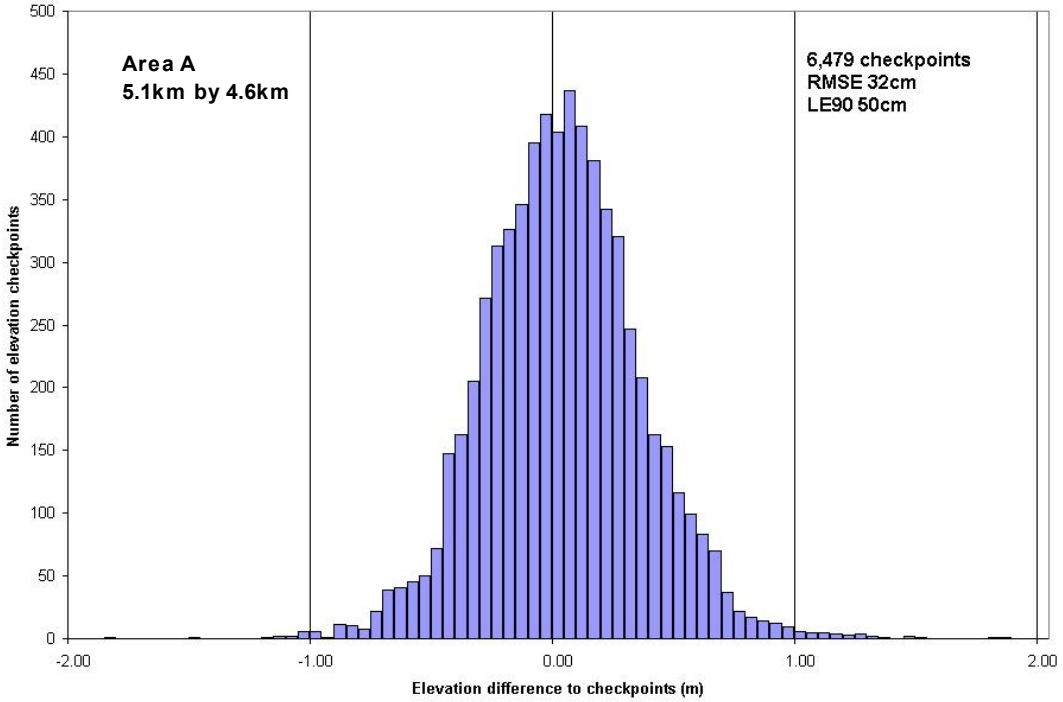

Figure 17. Histogram of the elevation differences between the WorldView-1 stereo satellite elevations for area A (5.1km by 4.6km) and the 6,479 elevation checkpoints, after the North-South adjustment by 4.3cm/km. RMSE 32cm, LE90 50cm. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

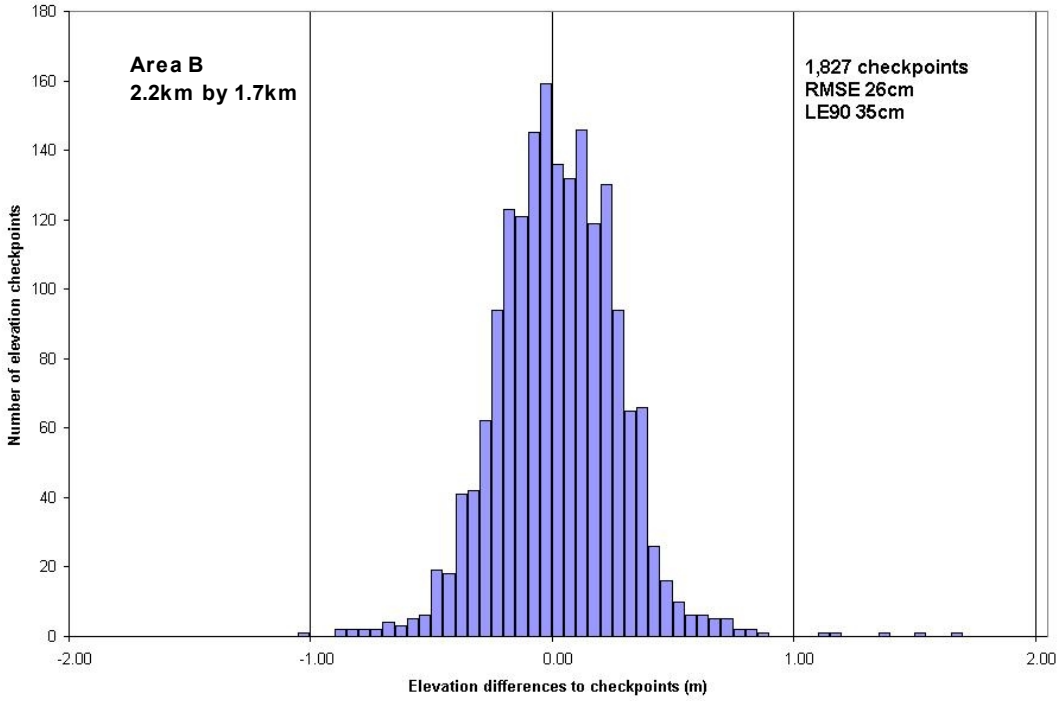

Figure 18. Histogram of the elevation differences between the WorldView-1 stereo satellite elevations for area B (2.2km by 1.7km) and the 1,827 elevation checkpoints, after the North-South adjustment by 4.3cm/km. RMSE 26cm, LE90 35cm. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

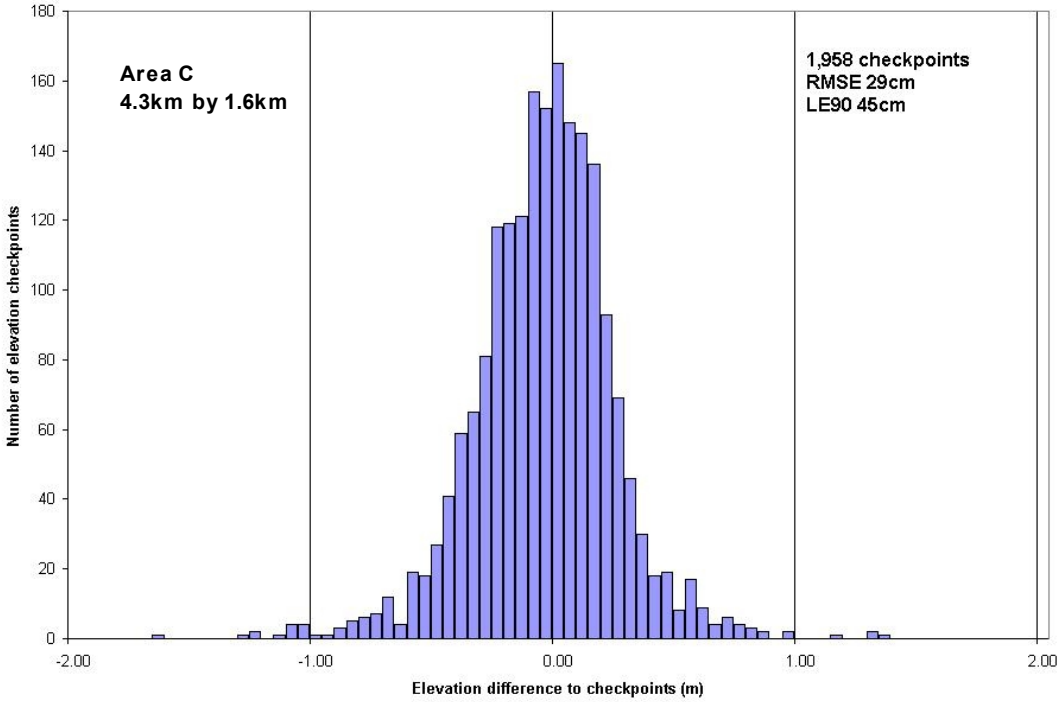

Figure 19. Histogram of the elevation differences between the WorldView-1 stereo satellite elevations for area C (4.3km by 1.6km) and the 1,958 elevation checkpoints, after the North-South adjustment by 4.3cm/km. RMSE 29cm, LE90 45cm. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

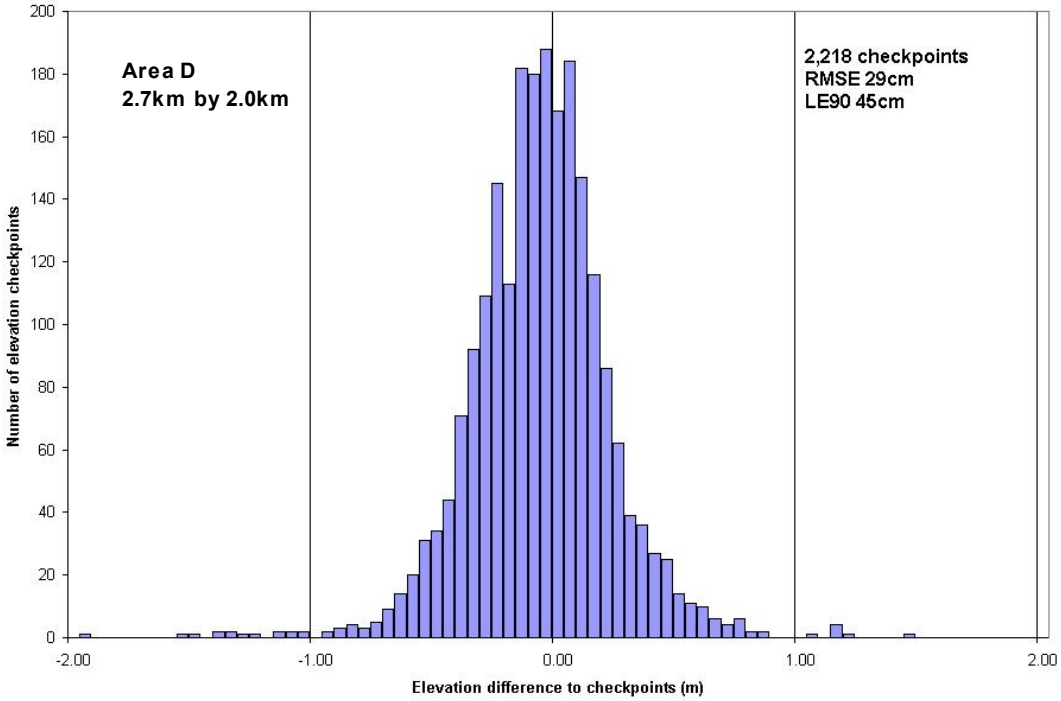

Figure 20. Histogram of the elevation differences between the WorldView-1 stereo satellite elevations for area D (2.7km by 2.0km) and the 2,218 elevation checkpoints, after the North-South adjustment by 4.3cm/km. RMSE 29cm, LE90 45cm. The elevation checkpoints are not in areas with slopes greater than 20% grade, beside buildings, nor on narrow topographic ridges.

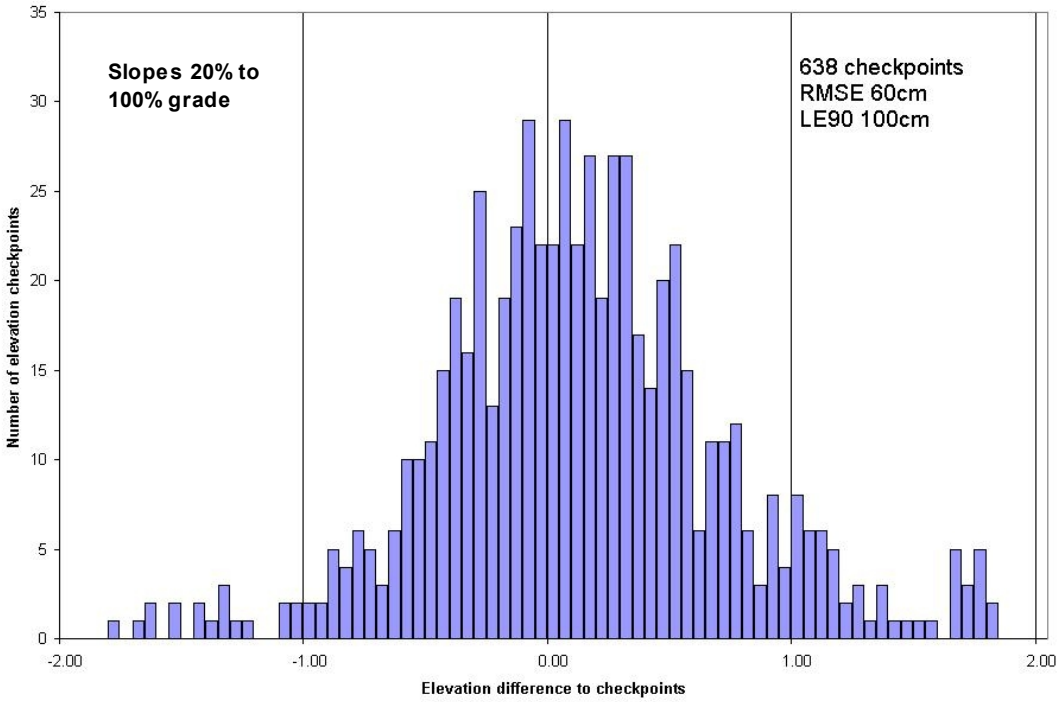

Figure 21. Histogram of the elevation differences between the WorldView-1 stereo satellite elevations for the 22km by 17km area and 638 regional elevation checkpoints in areas with slopes greater than 20% grade, after the North-South adjustment by 4.3cm/km. RMSE 60cm, LE90 100cm.

Cautionary Statement:
This is an accuracy assessment for elevation mapping from a single stereo pair of WorldView-1 satellite photos. While we expect that these results will be typical for most WorldView-1 stereo photos, we cannot yet confirm that these results apply to more than this pair of stereo photos.