Lambert, A., Mazzotti, S., van der Kooij, M., and Mainville, A., 2008: Subsidence and relative sea level rise in the Fraser River Delta, Greater Vancouver, British Columbia, from combined geodetic data, Geological Survey of Canada, Open File 5698, 1 CD-ROM.

FIGURES

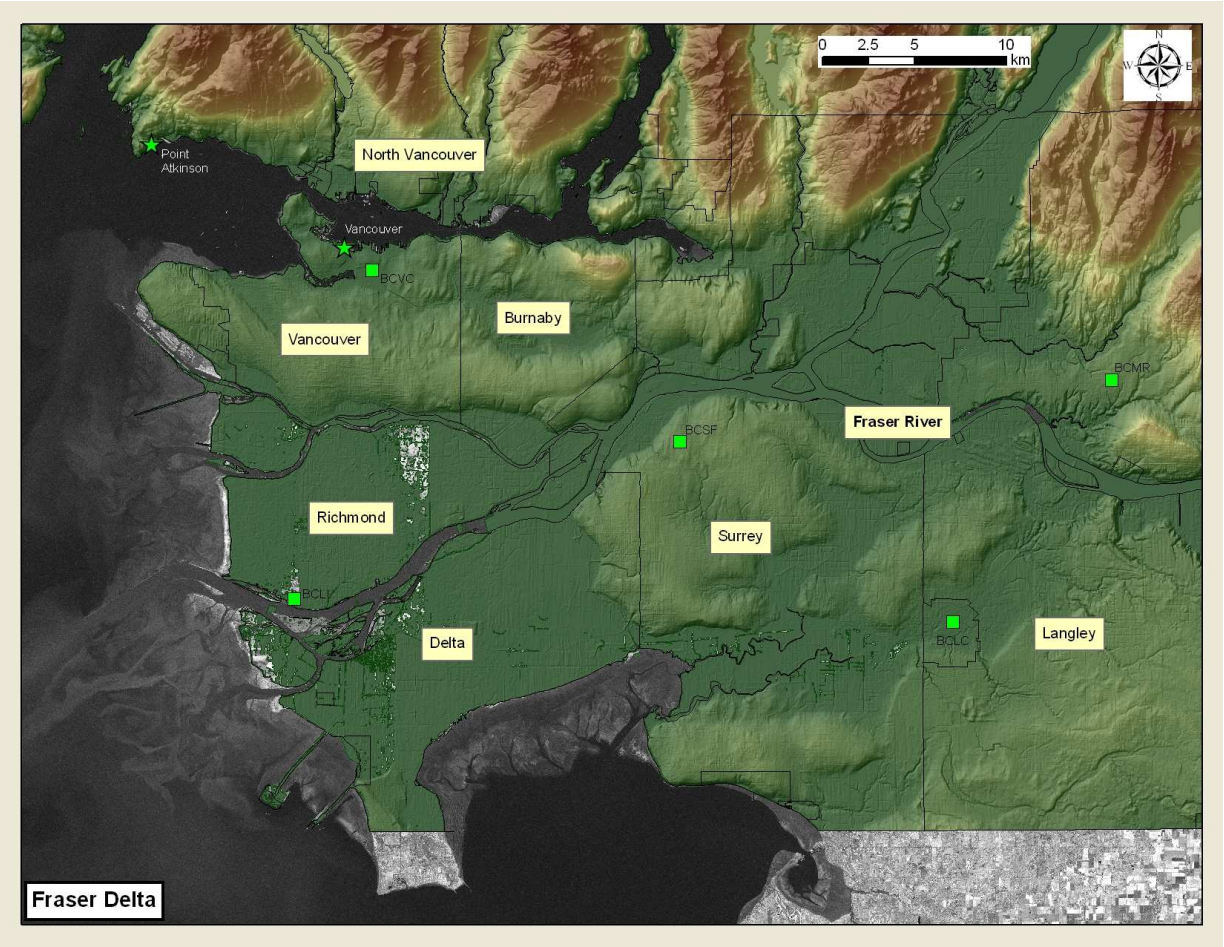

Figure 1. Fraser River Delta and Greater Vancouver. Topography shown by shaded relief (vertical exaggeration ~5). Light green squares show locations of permanent GPS stations and light green stars show locations of tide gauges in greater Vancouver area.

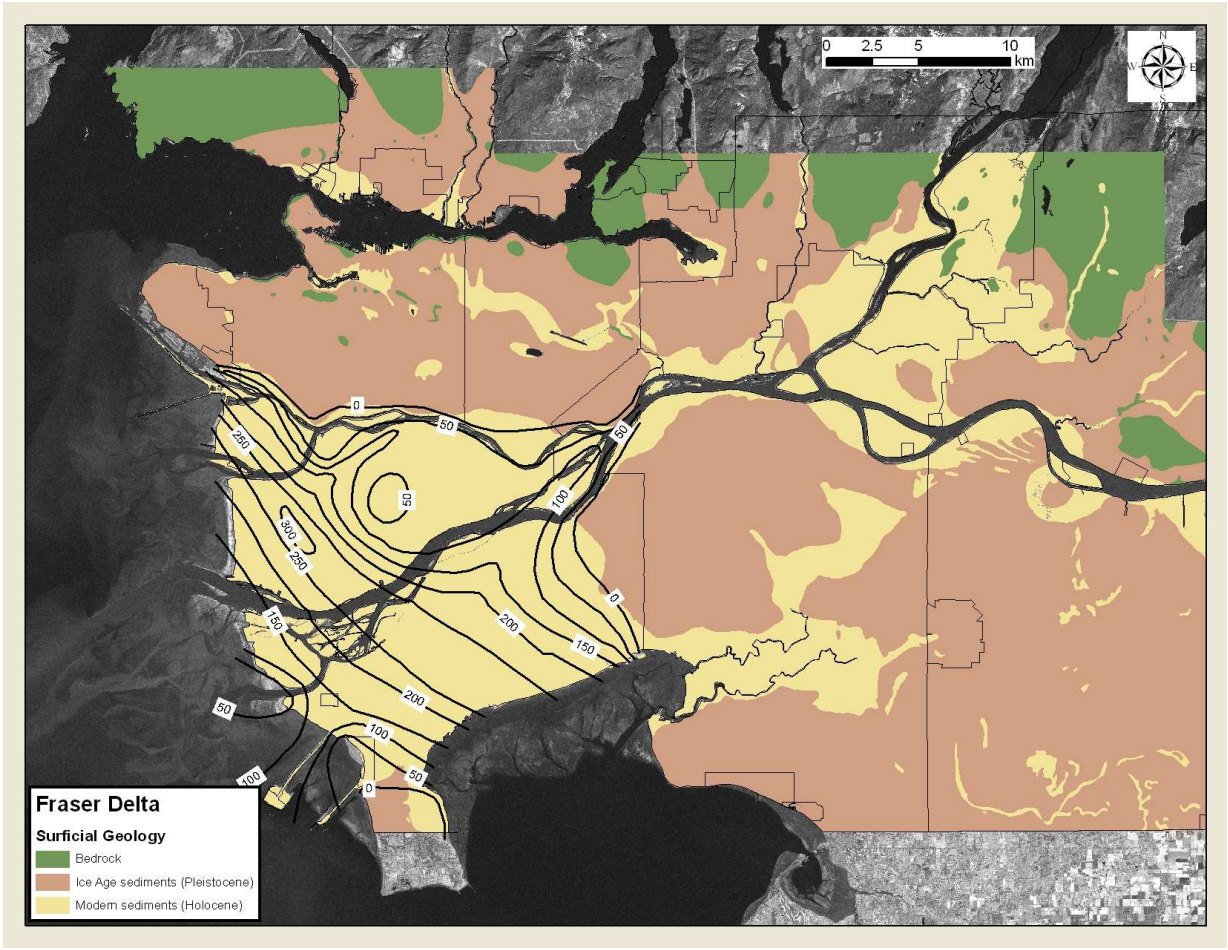

Figure 2. Surficial geology and Holocene delta sediments. Surfical geology divided into three main groups: modern (Holocene) sediments, Ice Age (mostly Pleistocene) sediments, and bedrock (Tertiary and older). Thick black lines are isocontours of Holocene sediment thickness (in meters) from Hunter and Christian (2001).

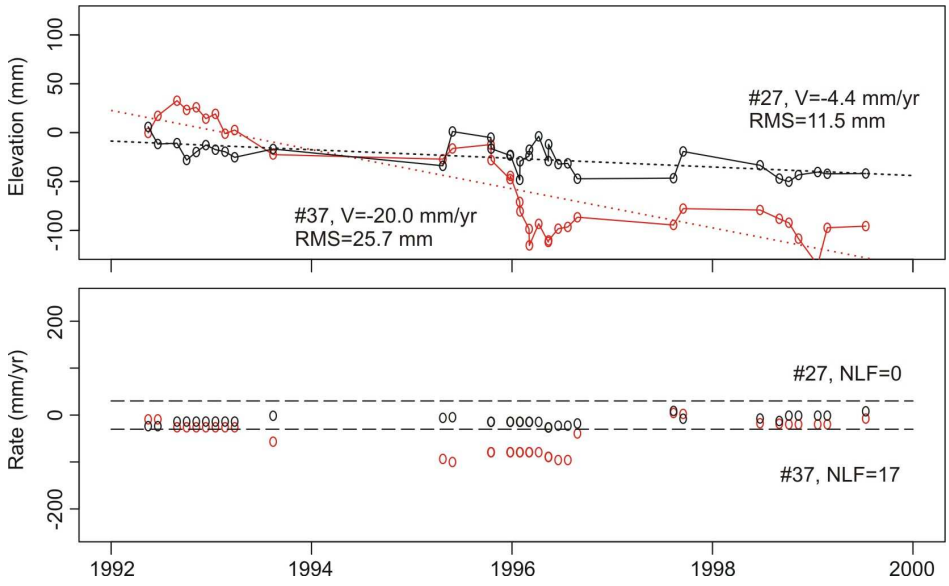

Figure 3. CTM-InSAR time series examples. Top: Scatterers #27 (black symbols) and #37 (red symbols) show examples of a steady linear series and a rapid transient series, respectively. Bottom: Two-year uplift rate series (cf. text) for scatterers #27 (black) and #37 (red). Scatterer #37 is a non-linear series that shows 2-year rates larger than the 30 mm/yr threshold numerous times. This scatterer was rejected from the results shown in Fig. 4.

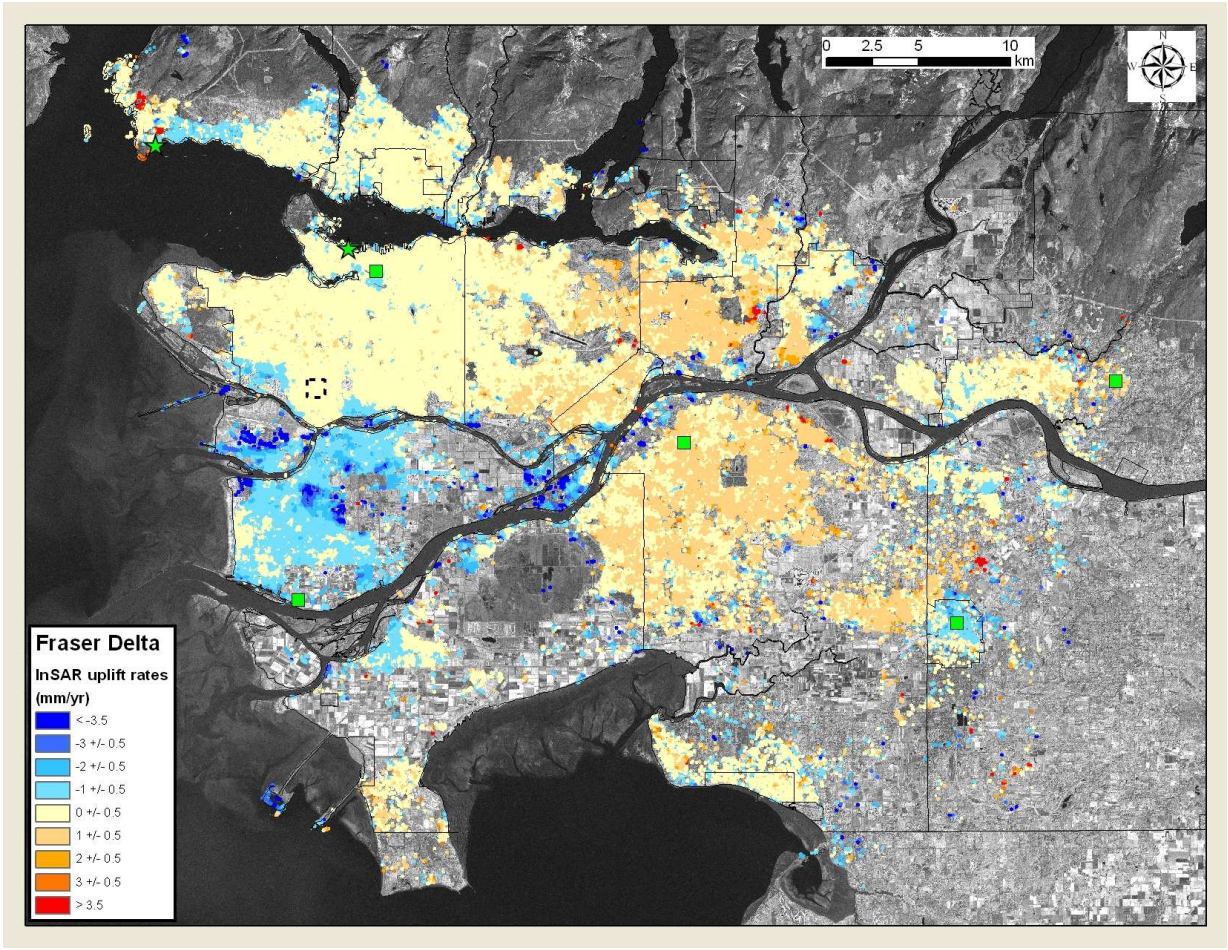

Figure 4. CTM-InSAR uplift rates. InSAR uplifts rates are smoothed using a 100-m radius moving-average circular window. The black dashed square shows the reference area. Light green squares show locations of permanent GPS monuments used in this study. Light green stars show locations of tide gauges. Note that small (~ 100 m), isolated features, particularly rapid uplift (red) features, should be treated with caution unless verified by other measurements.

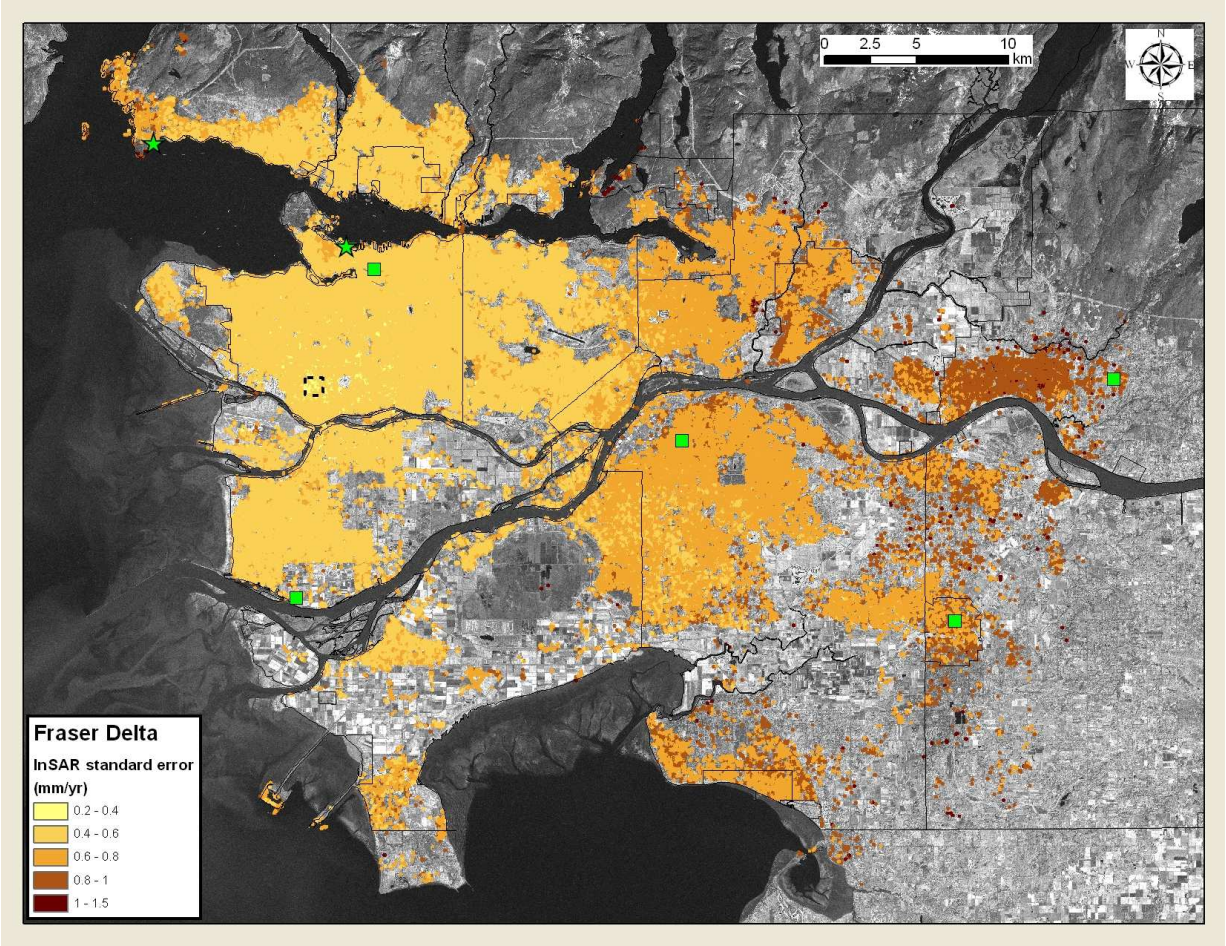

Figure 5. CTM-InSAR uplift uncertainties. Velocity uncertainties (standard errors) from individual pixels are smoothed using a 100-m radius moving-average circular window. The black dashed square shows the reference area.

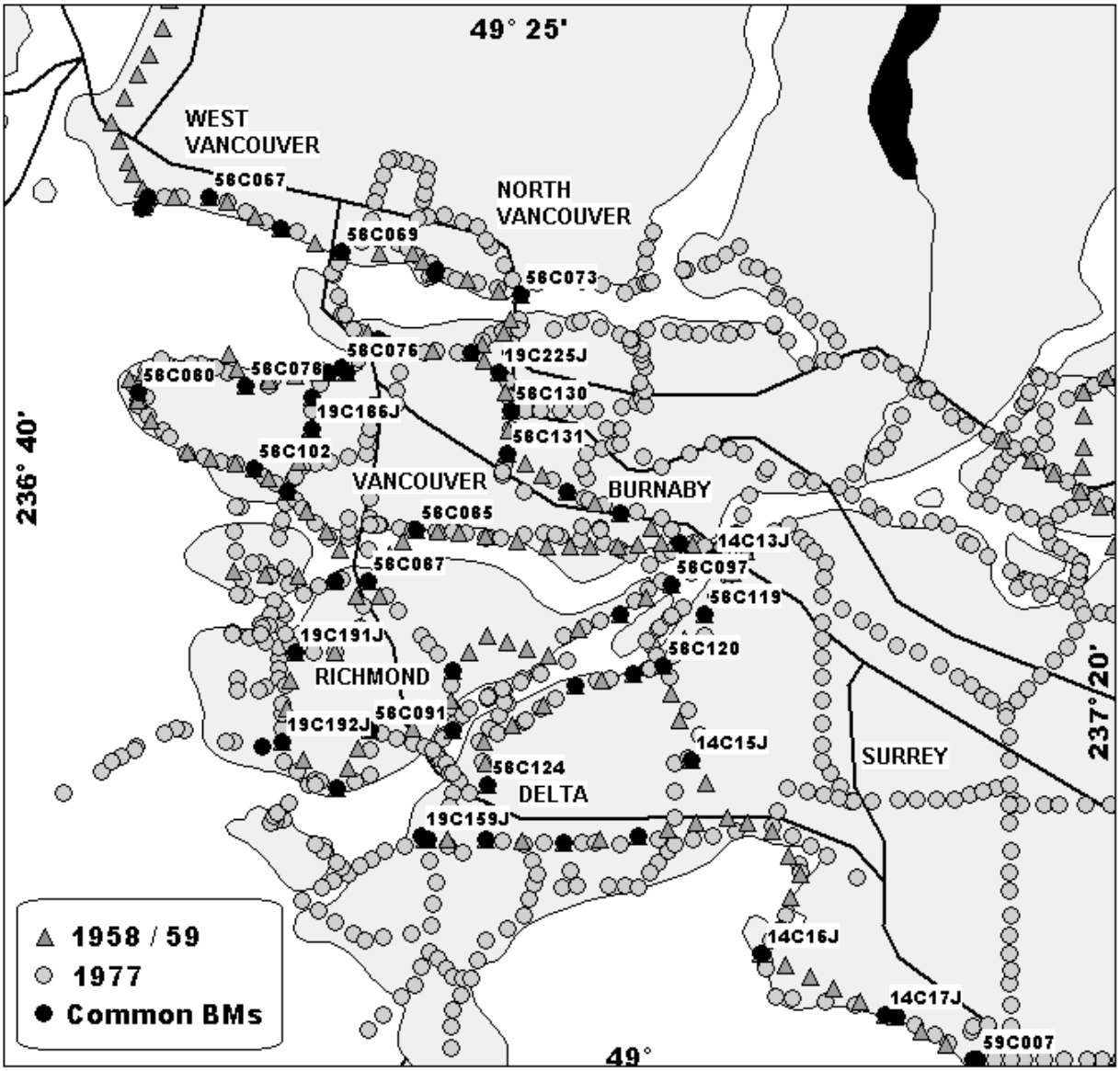

Figure 6. Location of vertical control bench marks in the Greater Vancouver area surveyed by Geodetic Survey of Canada in 1958/59 (triangles) and 1977 (circles). Common bench marks where relative vertical movement could be determined are identified by black filled circles.

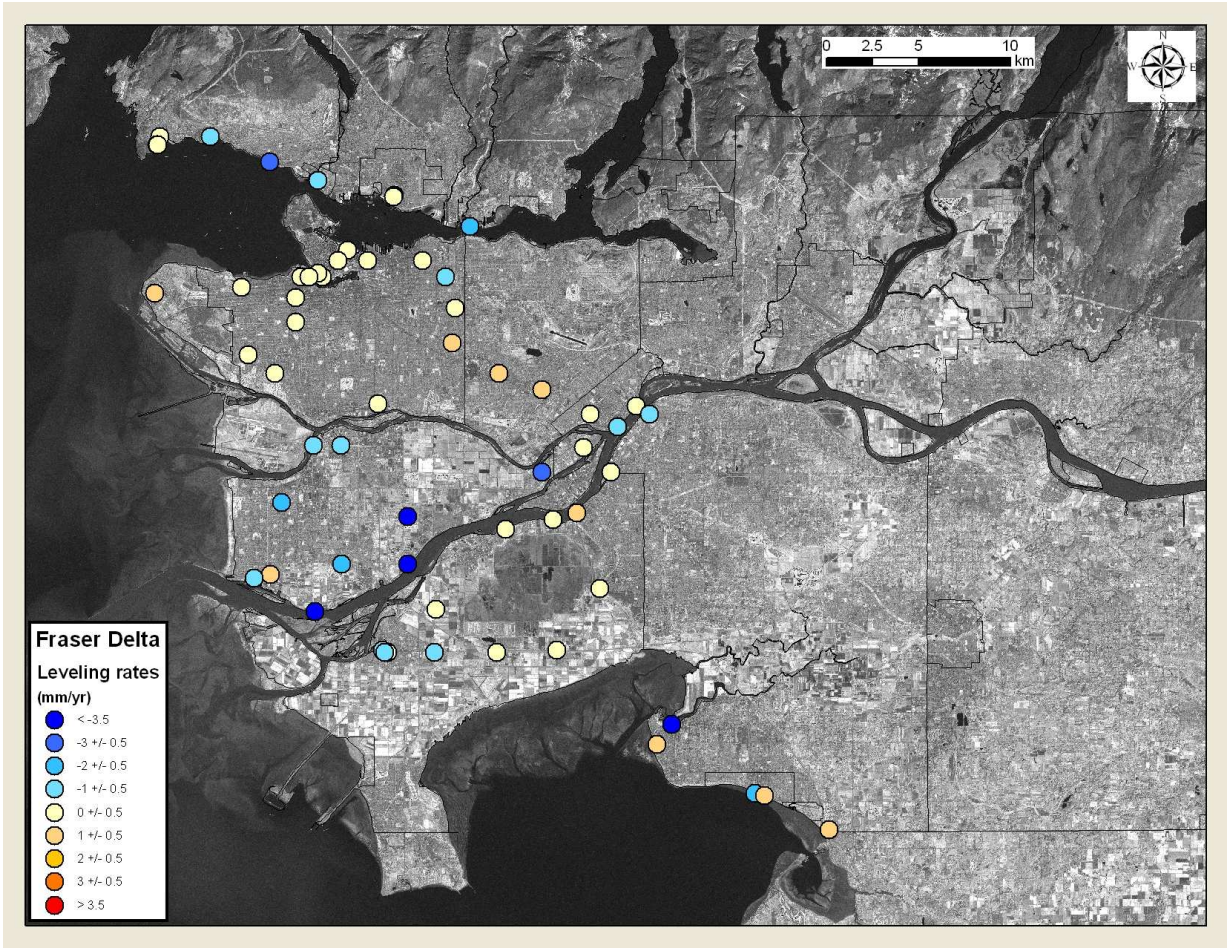

Figure 7. Relative vertical velocities of common bench marks from 1958/59 to 1977 in the Greater Vancouver area shown as colour-coded circles superimposed on a satellite image of the area. Blue denotes relative subsidence, red denotes relative uplift and yellow denotes zero relative movement from 1958/59 to 1977.

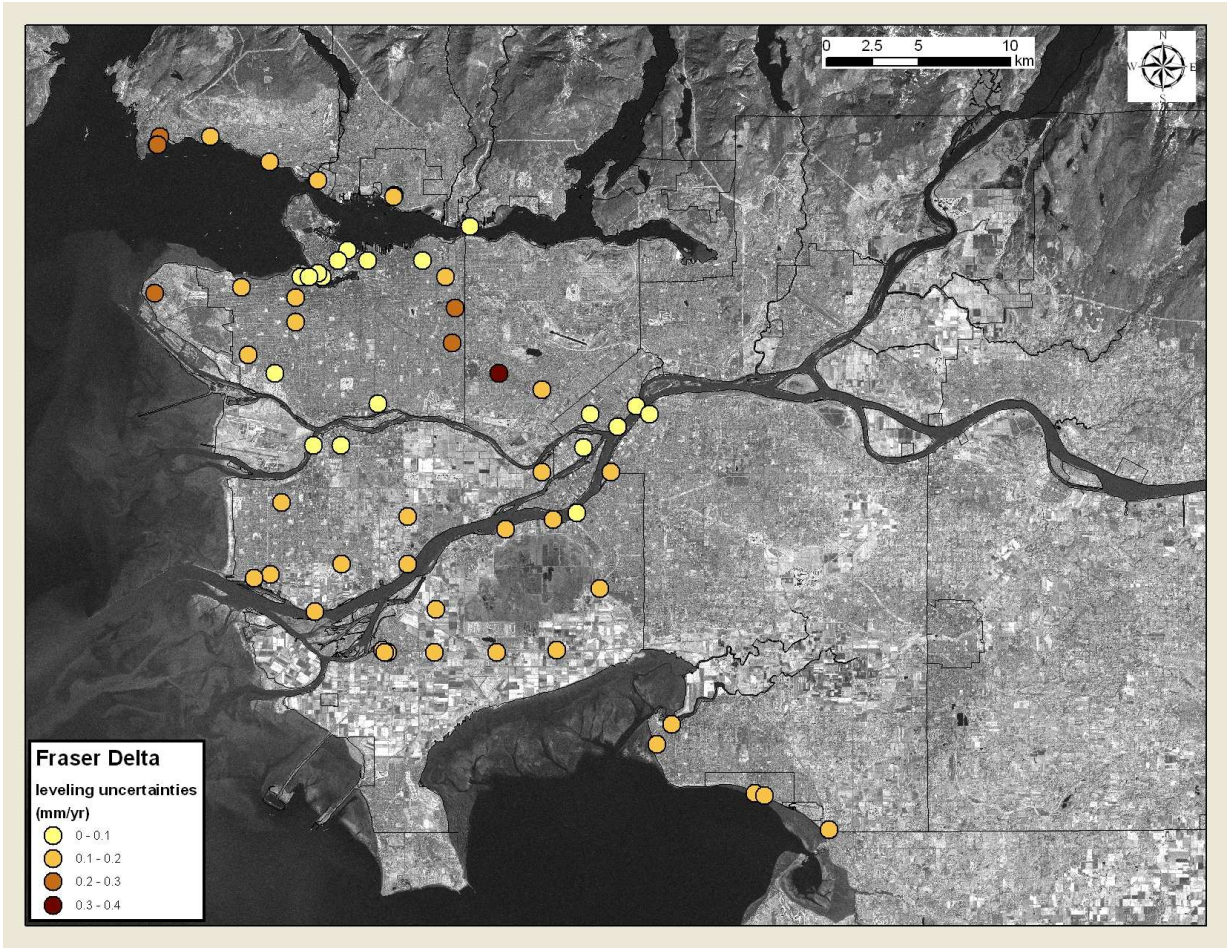

Figure 8. Standard errors on vertical movement rates from combined random and systematic errors in the 1958/59 and 1977 levelling surveys.

Figure 9. Aerial view of BC Ferries Corporation terminal at the south-west end of the Tsawwassen causeway showing the locations of former (red crosses) and existing (red dots) geodetic levelling benchmarks.

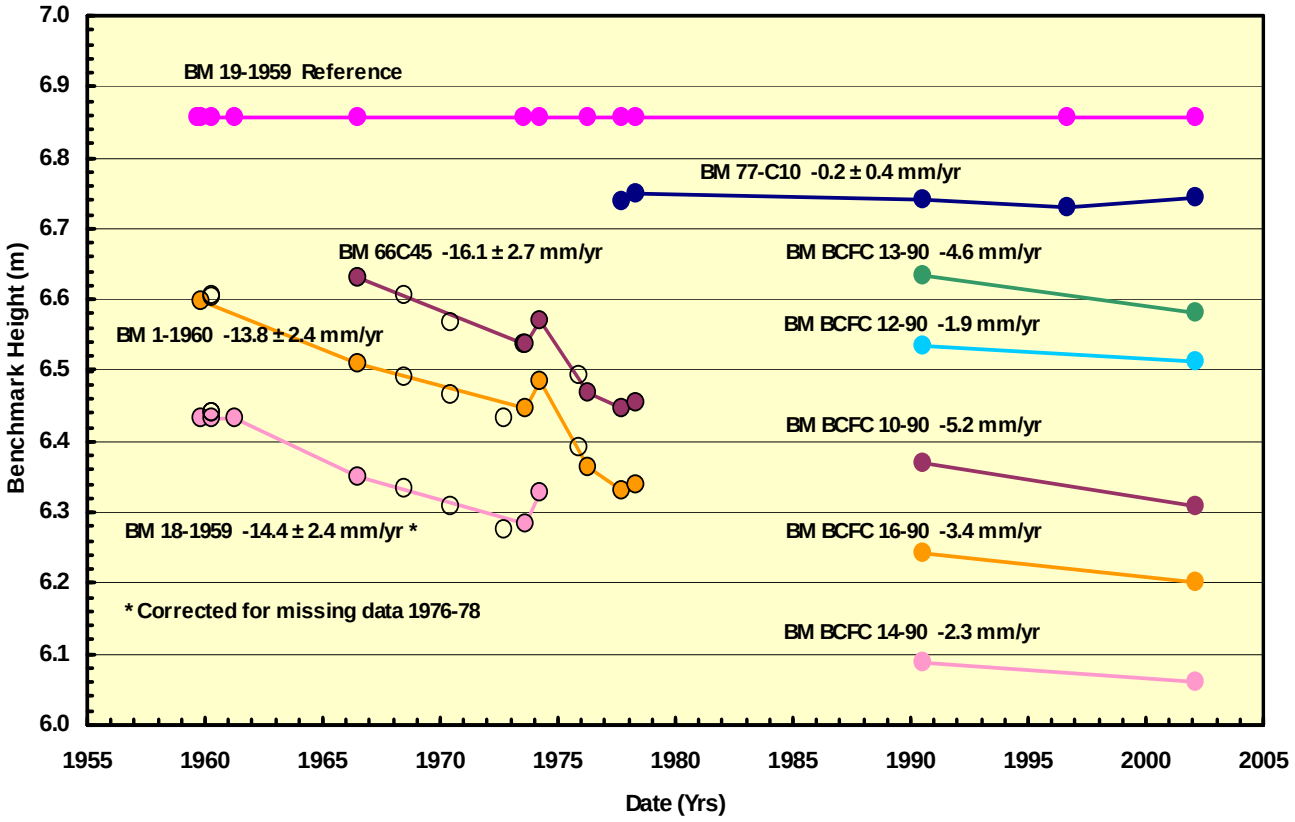

Figure 10. Vertical movements of geodetic bench marks at the BC Ferries Corporation terminal at the south-west end of the Tsawwassen Causeway from 1959 to 2002 with respect to reference bench-mark BM 19-1959 near the shoreline. Black open circles denote relative heights from local re-levelling not referred to the reference bench mark.

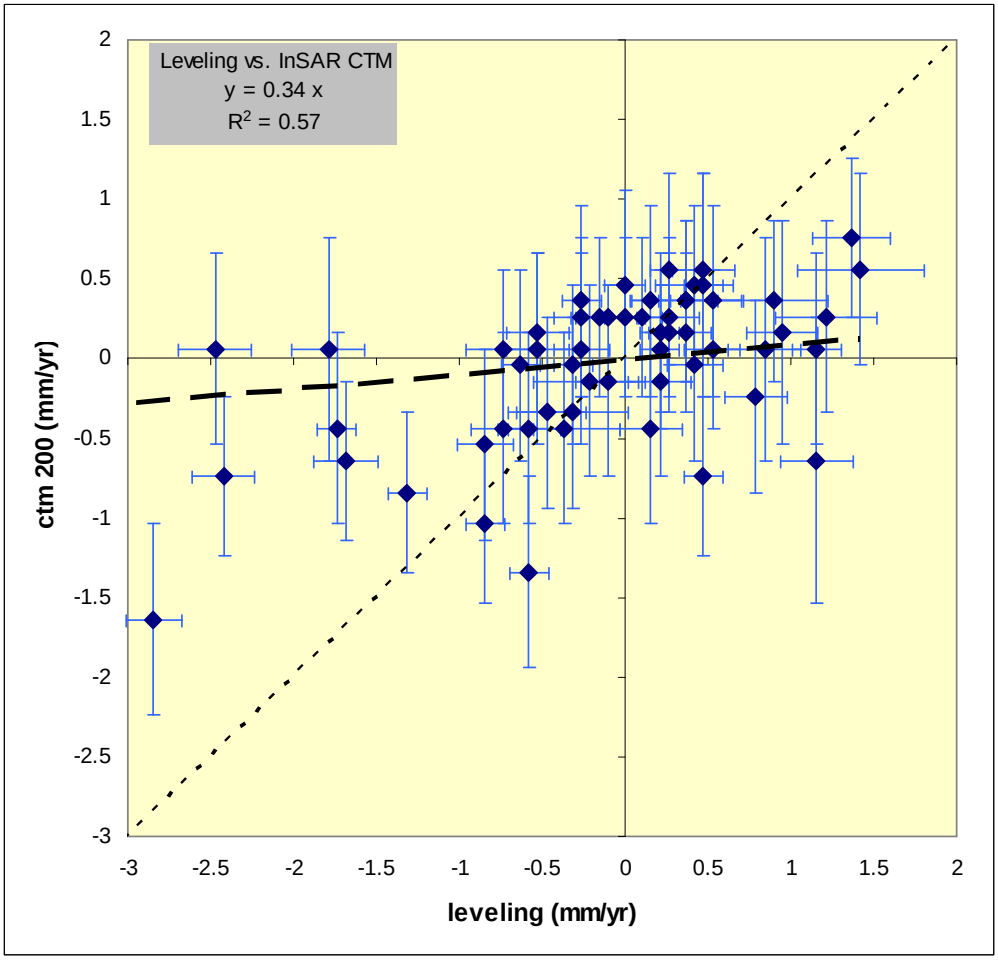

Figure 11. CTM-InSAR versus Levelling Uplift Rates. Blue diamonds are uplift rates at individual benchmarks in the GVRD from CTM-InSAR rates (averaged out to 200 m from the benchmark) versus the rates from levelling surveys. Error bars are standard errors. Thick dashed line is a linear regression showing a correlation of ~0.3.

Figure 12. Aerial view of the Tsawwassen causeway showing the locations of InSAR coherent targets colour coded according to their vertical rates. Levelling bench marks compared over the same epoch are shown as green triangles.

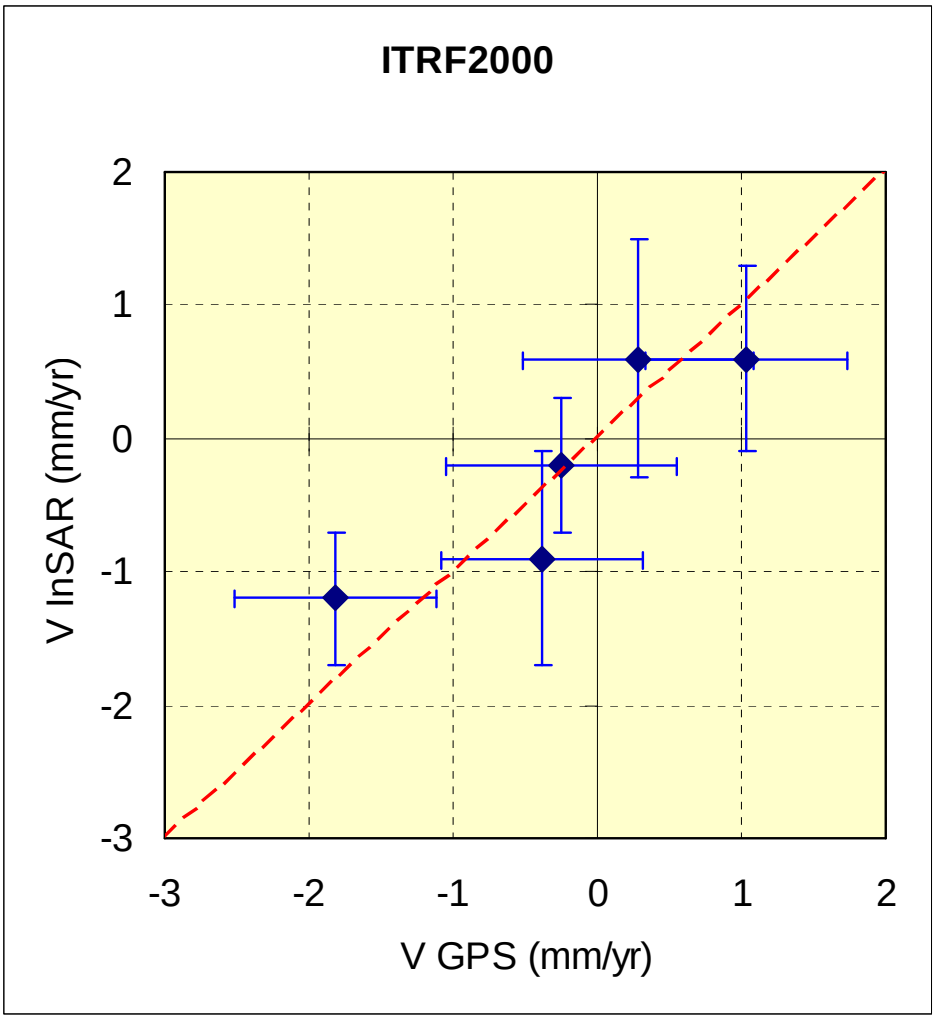

Figure 13. CTM-InSAR versus GPS vertical rates. Blue diamonds are CTM-InSAR uplift rates at GPS stations (averaged out to 200 m from the GPS antenna) versus GPS vertical rates. Error bars are standard errors. Dashed red line shows the 1:1 correlation slope.

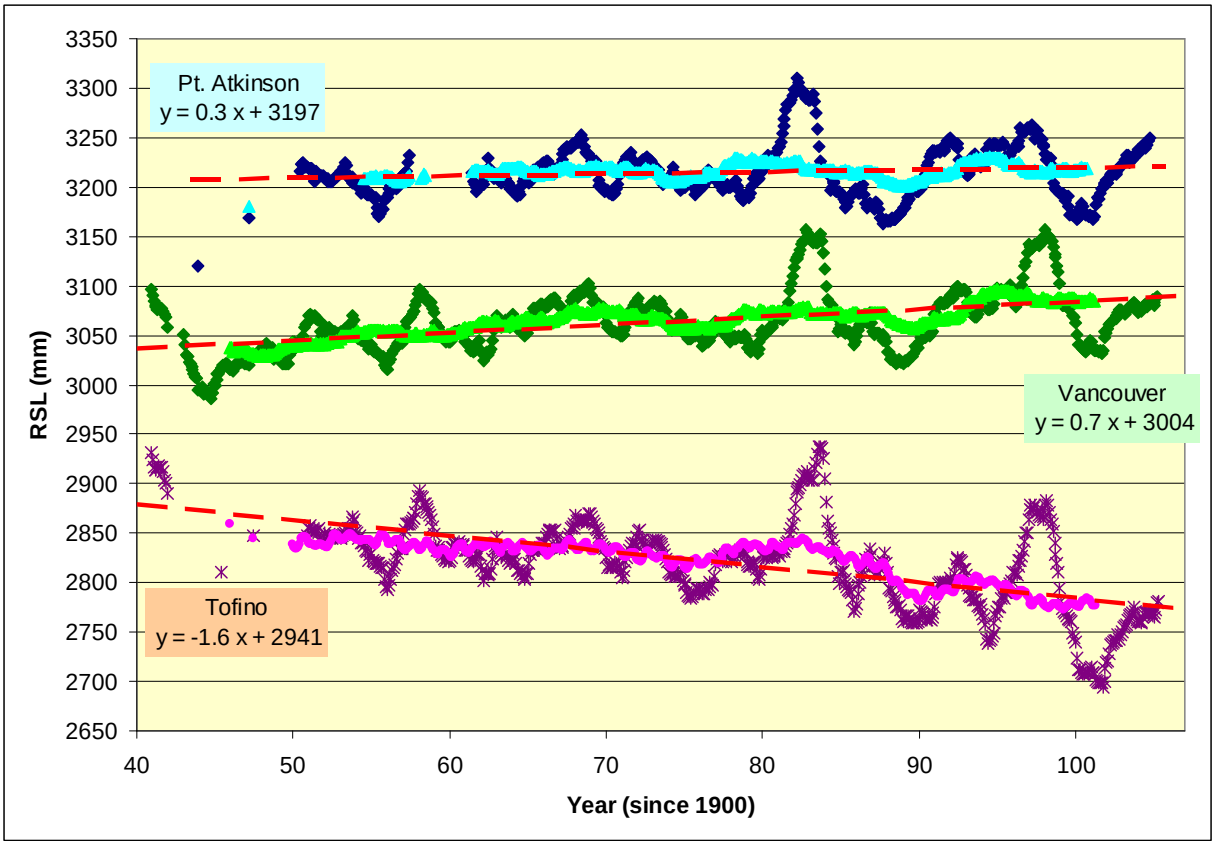

Figure 14. Tide gauges records of relative sea level. Dark and light color show 2-year and 10-year averages of the original monthly sea level data at the Point Atkinson (top), Vancouver (middle), and Tofino (bottom) tide gauges. Red dashed lines show linear regressions of the 2-year average data. Note the similarity of the 2-year average series at the yearly to decadal scale (e.g., El Nino events in 1983 and 1997).

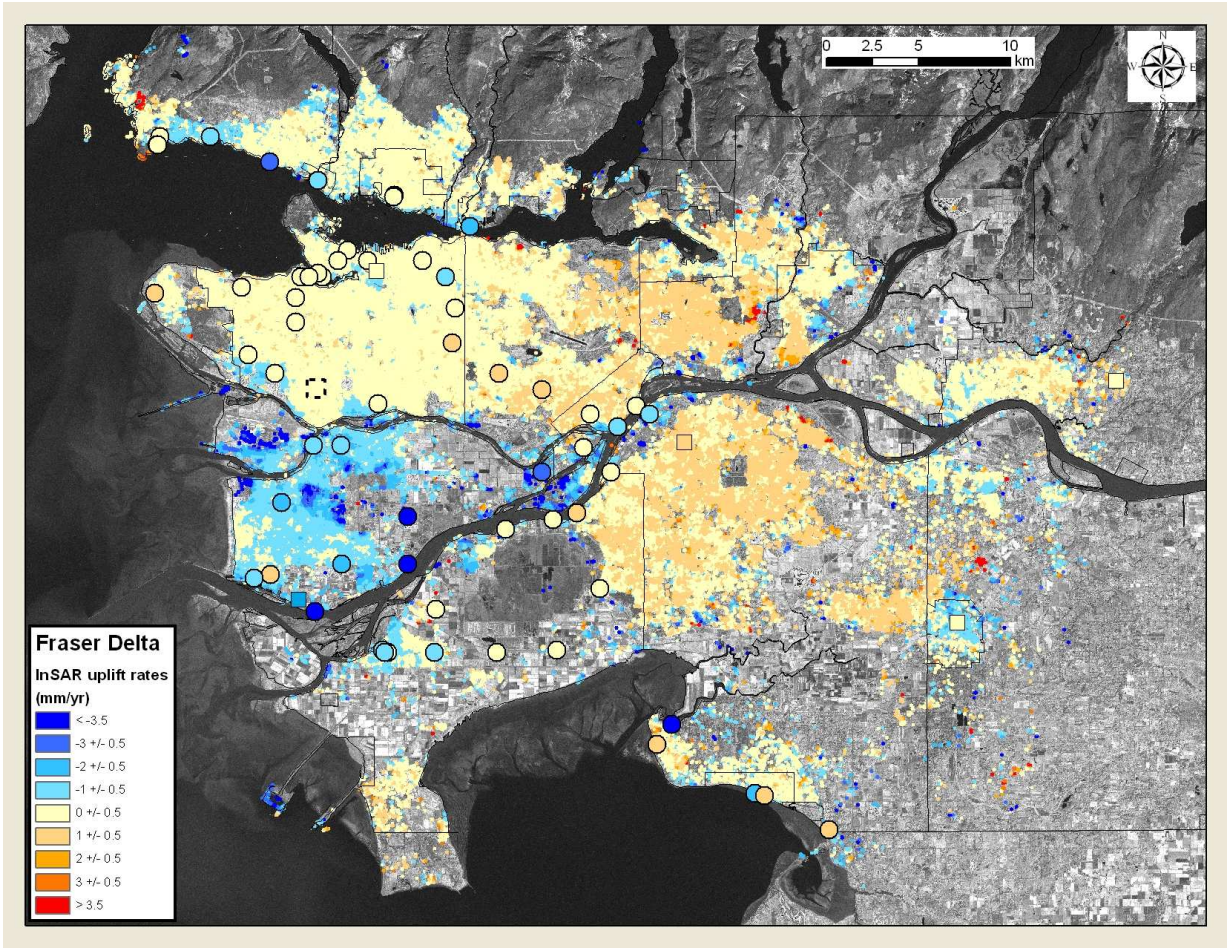

Figure 15. Comparison of CTM-InSAR, levelling and GPS vertical rates in the GVRD. The vertical rates of the permanent GPS stations and the vertical rates of levelling bench marks are indicated by filled squares and filled circles, respectively. The colour code for the GPS and levelling is the same as for the InSAR.

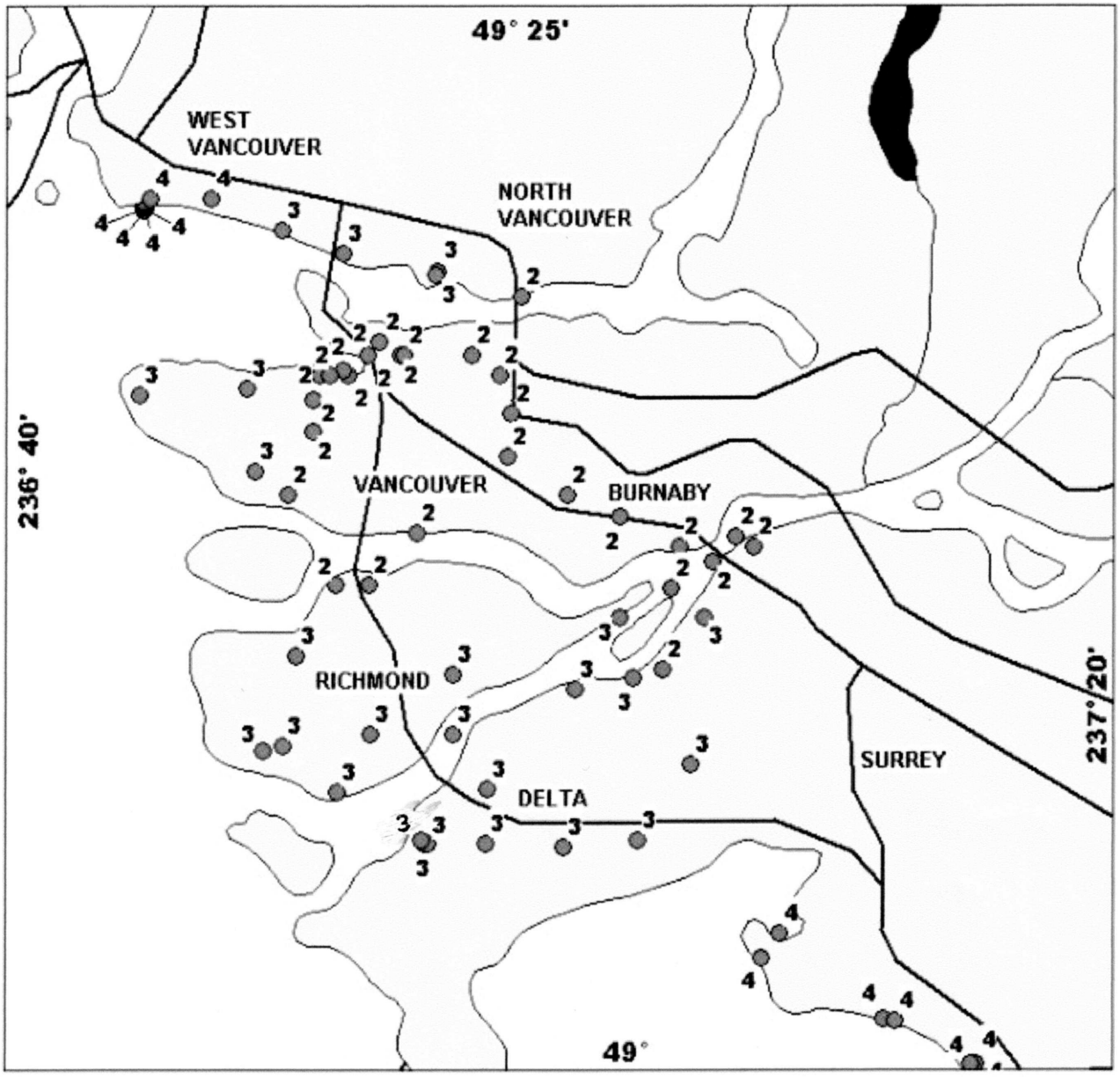

Figure A1. Combined, random, one-sigma errors of height changes (mm) between 1958/59 and 1977 expressed with respect to the common network mean bench mark height.

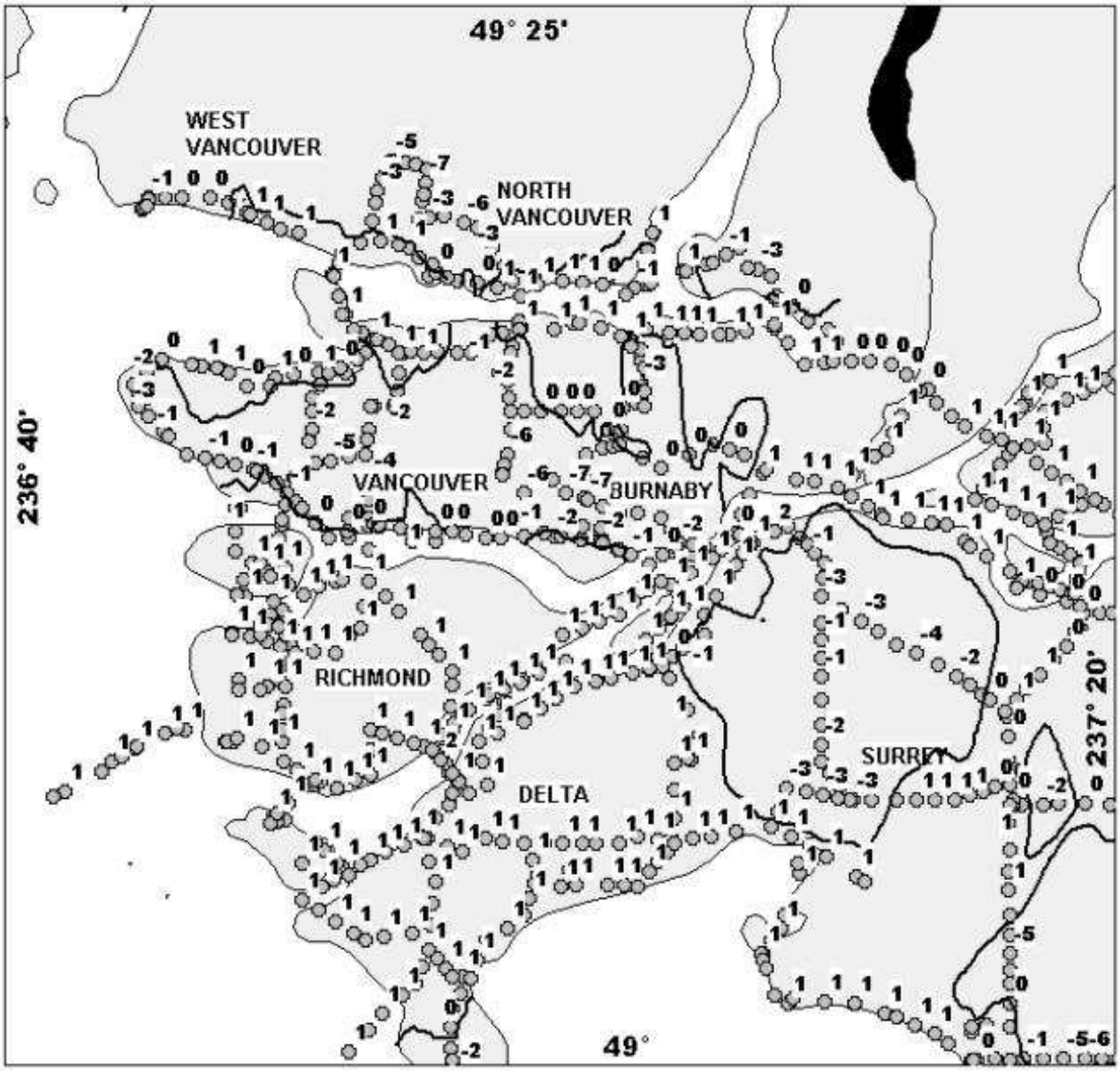

Figure A2 a) Rod-scale corrections applied to the 1977 levelling heights in mm expressed with respect to the common network mean height. The contour line denotes the location of the mean elevation (20.776 m) of the 61 bench marks common to the two surveys. Bench marks close to this contour, by definition, have very small height change corrections for rod-scale calibration.

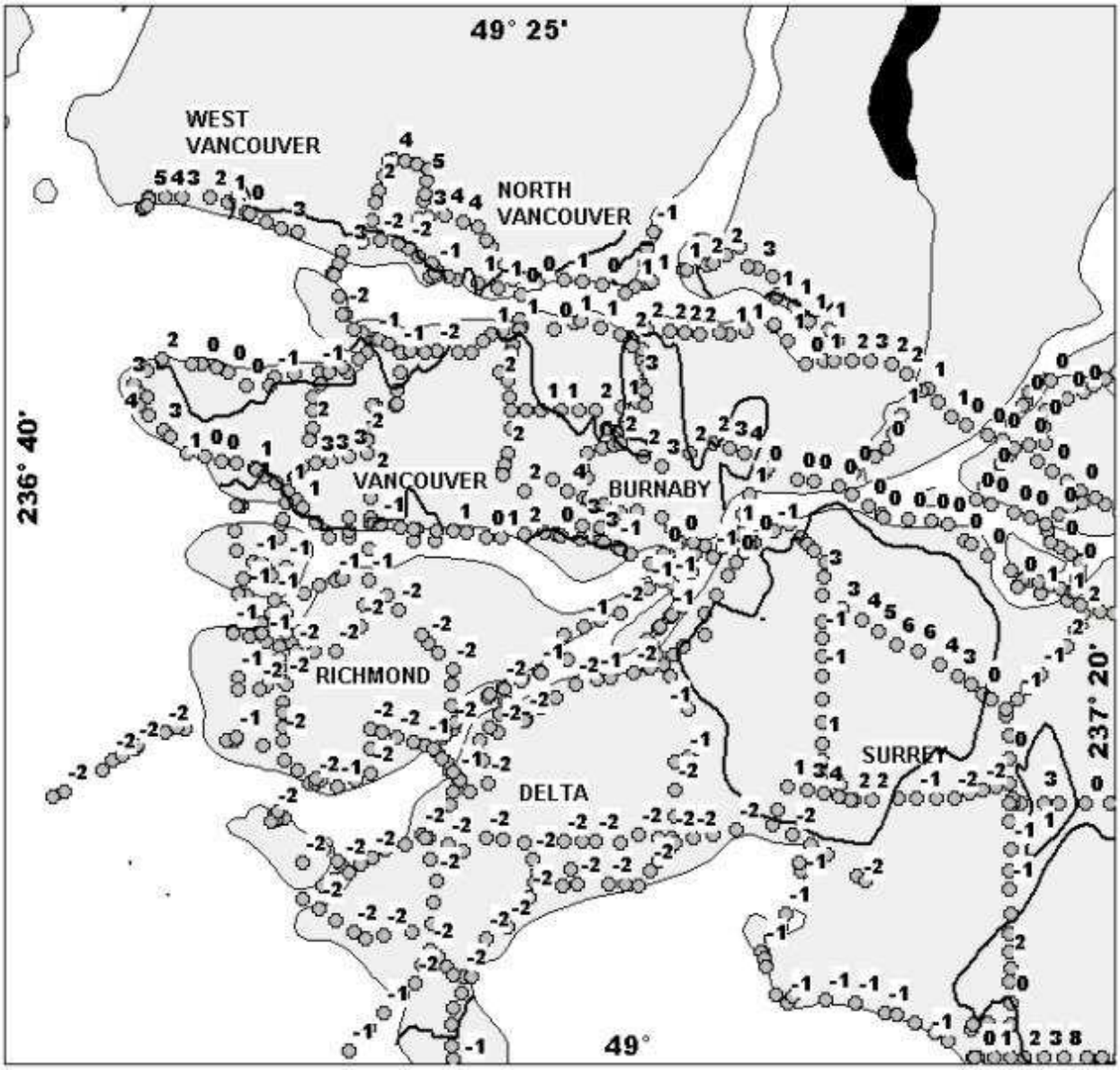

Figure A2 b) Refraction corrections applied to 1977 levelling heights in mm expressed with respect to the common network mean height. The contour line denotes the location of the mean elevation (20.776 m) of the 61 bench marks common to the two surveys. Bench marks close to this contour, by definition, have very small height change corrections for refraction.

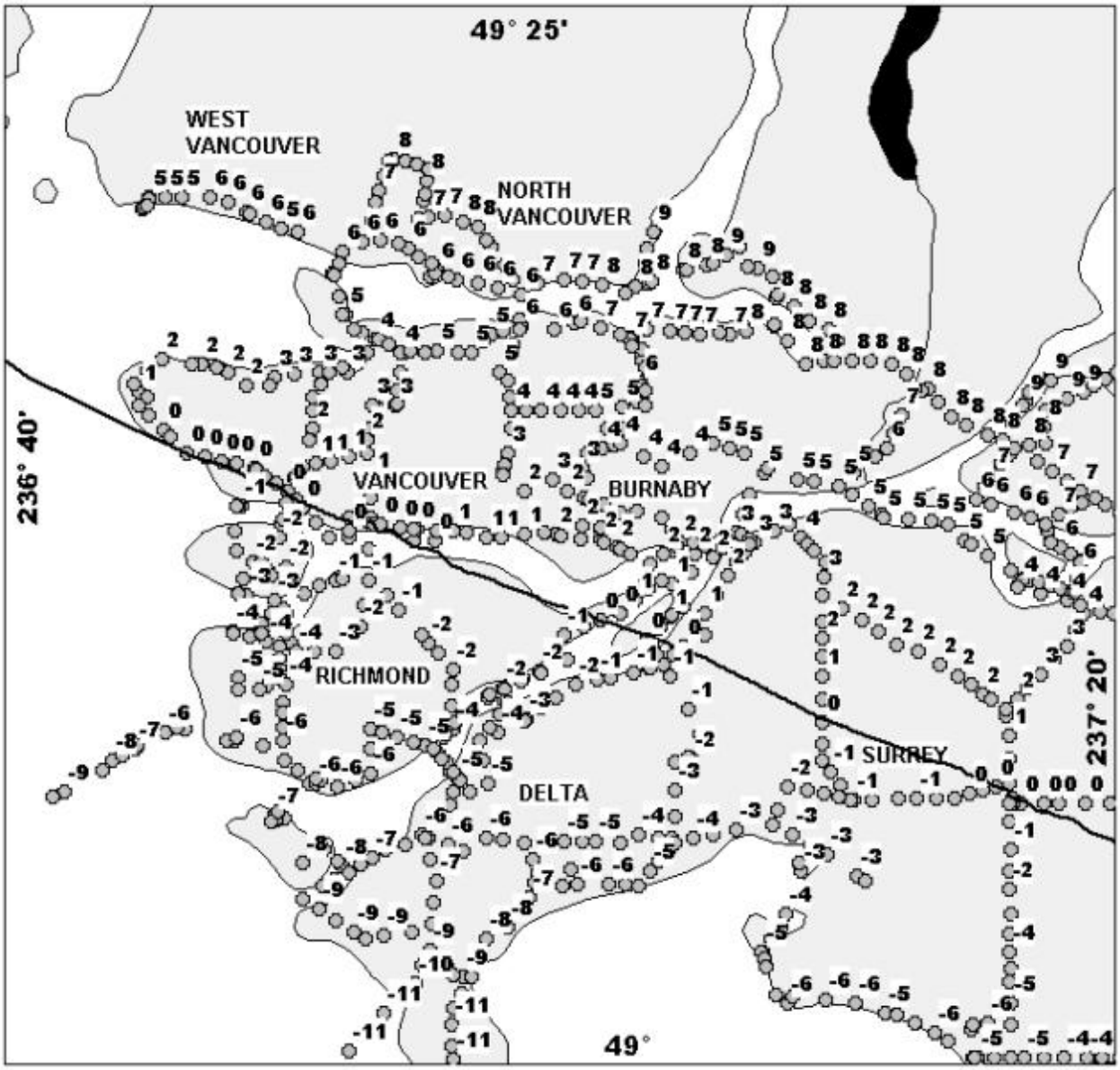

Figure A2 c) Magnetic-effect corrections applied to 1977 levelling heights in mm expressed with respect to the common network mean height. The contour line denotes the mean magnetic latitude of the network where the magnetic effect corrections are defined to be zero.

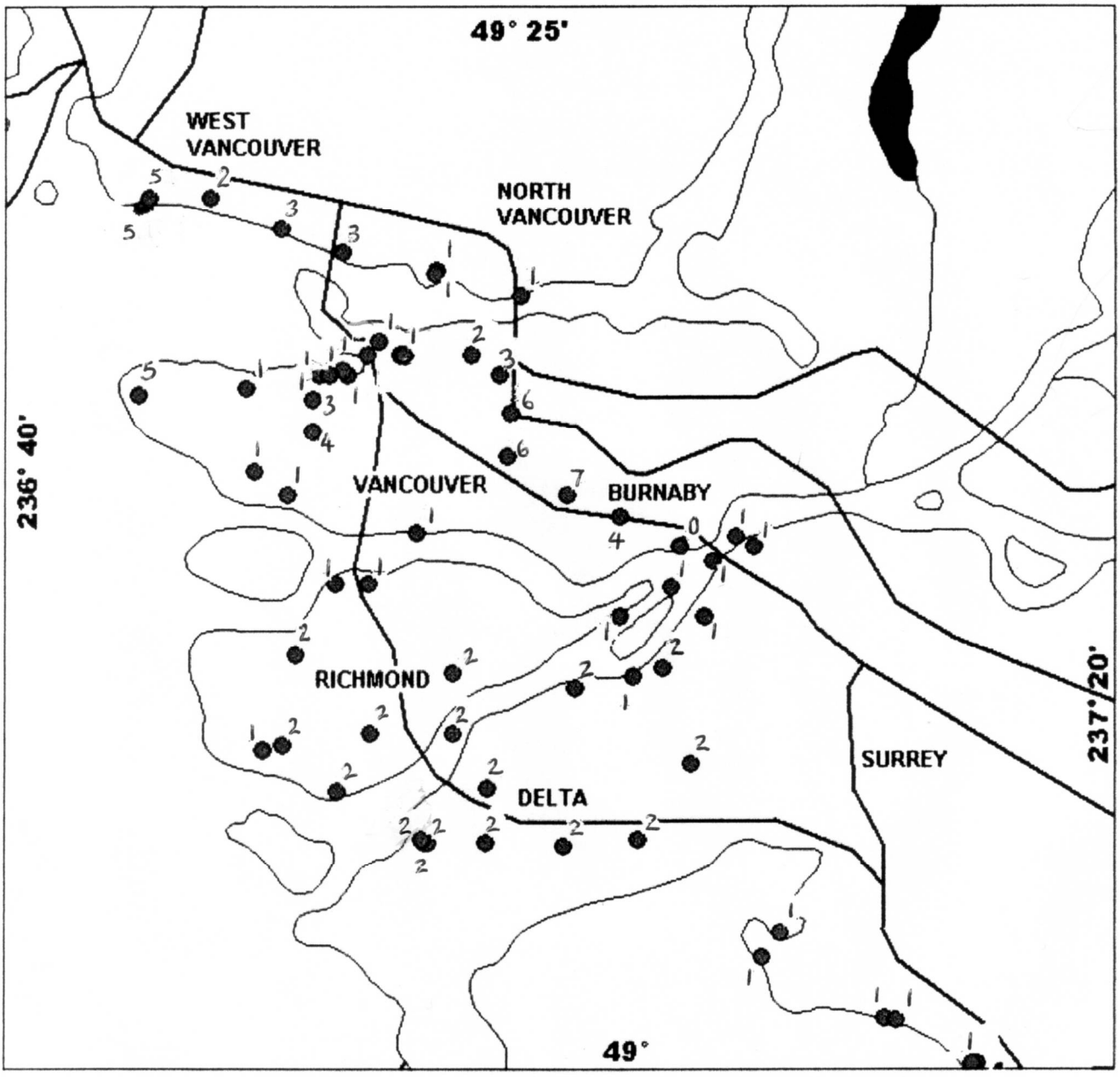

Figure A3. Combined, systematic, one-sigma errors in height change in mm from 1958/59 to 1977, estimated from rod-scale and refraction uncertainties.

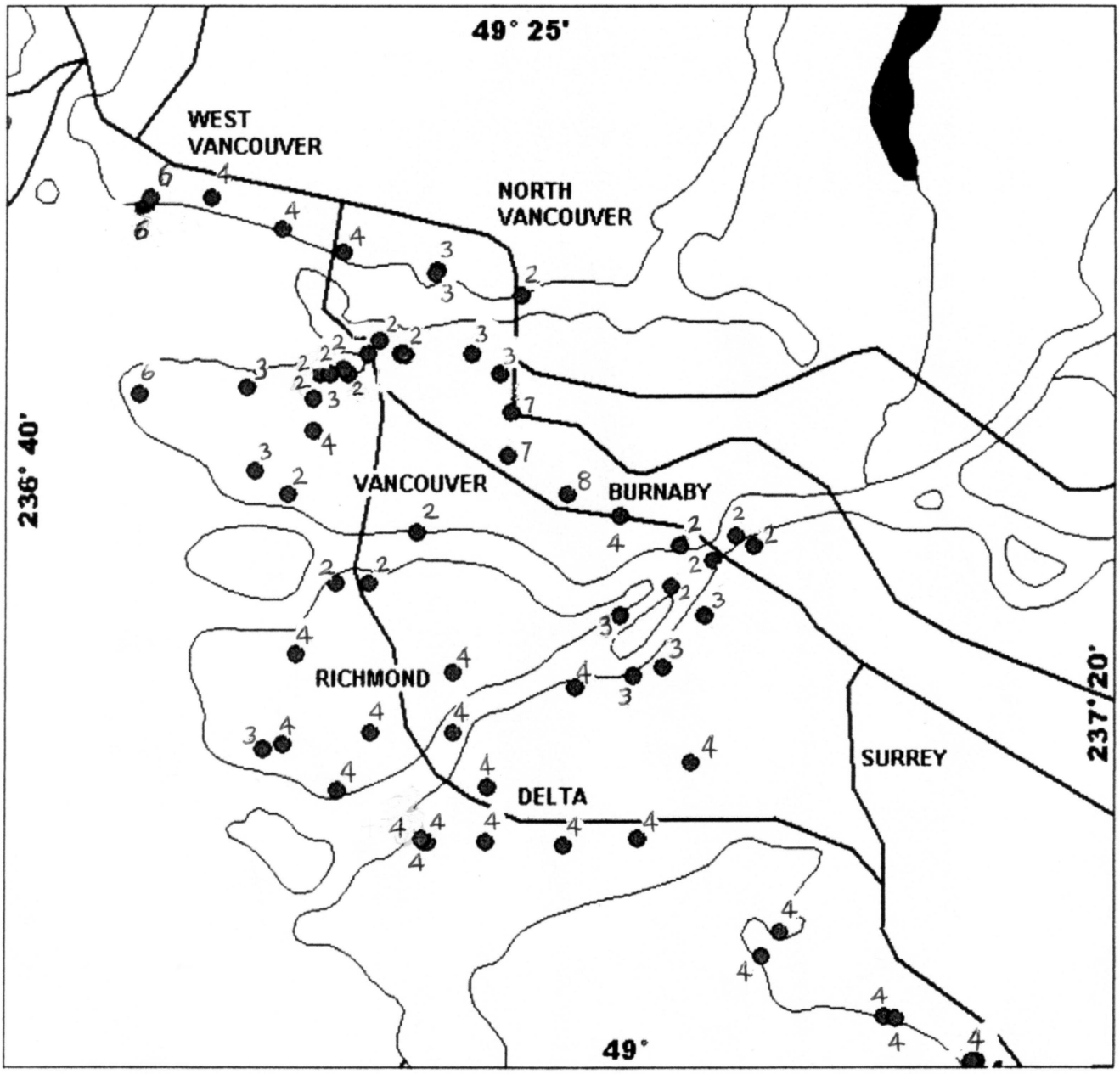

Figure A4. Combined systematic plus random errors in height change in mm from 1958/59 to 1977.