

The question as to the best kind of triangulation to be adopted is perhaps a little more open to argument. For many reasons, however, I am led to recommend, as the fundamental framework, a system of major triangles of as large size, up to fifty or sixty miles' side, as the form of the country will allow; these to be afterwards broken down into secondary and tertiary triangles as required. The chief advantage of a triangulation such as this over one of a more limited kind is that, in conforming to the well-known principle of working inwards from the greater to the smaller, it largely reduces the probable errors of the work, and does so at but a slight extra outlay. Exactly the same number of stations are occupied in either case, and the only additional expenses incurred are in the purchase of a larger class of instruments, the greater difficulty of getting them from place to place, and the cost of using the heliostat for observing very distant points. A sum of from £8,000 to £10,000 would certainly cover the extra charge. By this moderate addition you would lay the foundation of the whole structure of the survey in a thoroughly accurate and efficient manner, at but a tithe more than the cost of doing it imperfectly; and there is perhaps no scientific undertaking to which the maxim that what is worth doing at all is worth doing well applies more truly than to this. The officers who conducted the English survey insisted from the very first on strictly good and correct work in every detail, and for a long time were well abused for their pains. Now, the country but too gladly acknowledges the wisdom that was shown in their timely and enlightened adherence to accuracy. A triangulation, once completed, stands for all time. It is the framework on which a survey on any scale whatever may be laid down; and if accurately carried out, it forms the basis for geodesical measurements. No pains, therefore, should be spared to do it thoroughly once for all. It will then repay its cost over and over again.

The sides of the Primary triangles should vary from fifteen or twenty miles up to fifty or sixty—the larger the better, if well-shaped triangles are preserved; and the angles should be observed with instruments of from twelve to eighteen inches circles, four of which would need to be bought, at a cost of about £1,200.¹ A base line from six to eight miles long should be measured in each island with the best apparatus. For that in the North Island, a good site might, I think, be found either on the Taupo or Napier plains; in the South, on the plains of Canterbury. The triangulation would be carried across Cook Strait, and the bases be thus connected and a verification obtained. One fundamental latitude, longitude and meridian should be determined at a convenient station of the survey, and used in computing the latitudes and longitudes of the remainder, azimuths of verification being observed at other distant points. This network of great triangles should cover the whole country, and a selection from existing points should be used if possible in the districts already triangulated.

In the Secondary series, the sides would vary from eight to fifteen or twenty miles, and the angles at these stations might be observed with eight and ten-inch instruments. Such triangles should only be extended over areas already occupied, or likely to be within say twenty years,² and not yet covered with a triangulation of this class.

For the Tertiary or minor series, sides of from two to three or four miles, and six-inch instruments, will answer. There will be no need to extend this branch of work to the areas already thus observed, but it should be systematically spread over all new survey districts, over all of the old work that needs revision and correction, and thereafter as required for settlement. Where minor triangulation is rendered impossible or too expensive by dense forest or other physical obstacles, cardinal lines, whether straight as in the direction of the meridian, or following the course of existing or probable main roads, should be laid out very carefully in connection with the secondary stations, as a basis for detail surveys, with permanent marks at about every mile.

To carry out the whole system of triangulation thus suggested, a special branch must be organized, and placed under the sole control of a permanent Surveyor-General, whom, for the present, we will consider as trigonometrical only. This officer should have a competent knowledge of both the practical and theoretical part of trigonometrical surveying, and of the sciences of astronomy and geodesy in their relation to it. It would be his duty to devise and control the whole system of trigonometrical operations, and the calculations connected with them; and he should be competent to superintend on behalf of the colony the determination of difference of longitude from the Sydney or Melbourne Observatory, an undertaking which cannot be very far distant. It seems fitting, also, that the central time establishment of the colony, which I understand is likely to be soon set on foot, should be placed under his direction. He would need as his immediate *aide* a Secretary accustomed to the use of instruments and with good mathematical knowledge, able to assist personally in the more delicate observations and other field processes and the higher calculations, and if necessary to carry on the work of the department in the temporary absence of his chief. The rest of the staff would vary in number as the work progressed. I think most if not all of them might with a little training be provided out of the existing departments. It would rest with the Surveyor-General himself to decide whether the introduction of a small leaven of highly experienced observers from home might be desirable or not; but I am disposed to think that the advantage to be gained by doing so is not equal to that

¹ The £5,000 already voted would more than cover all preliminary expenses and apparatus. There are (or will shortly be) in Auckland four ten-inch and two twelve-inch instruments, the property of the Colonial Government, all in good order, besides inferior ones; and there are five or six good eight-inch and six-inch instruments in the different provinces.

² In wild districts, however, a number of intermediate points should be fixed by observations from the stations of the great triangles, to serve as a basis for topographical surveys.