PUBLICATION OF THE NETHERLANDS GEODETIC COMMISSION

GEODETIC WORK

IN

THE NETHERLANDS

1957—1960

Report presented at the Twelfth General Assembly of the International Association of Geodesy at Helsinki 1960

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I TRIANGULATION

1.1 **Primary triangulation, the Netherlands, 1957–1960**

1.1.1 *General information*

The measurement of the Netherlands-German connection network, which is situated between the primary stations Finsterwolde, Windberg, Hesepe, Bentheim, Oldenzaal, Uelsen, Sleen and Gieten, was completed in 1958. The misclosures in the triangles were respectively: −1.08, −0.47, +1.76, +0.52, +0.59, +0.92, −3.03, −1.94, +1.49 and −0.56 dmgr.

Measurements for the southern junction network have been performed at the station Kevelaer by the "Landesvermessungsamt Nordrhein-Westfalen". The results of these measurements were received in 1959, so that the connection between the Netherlands and German networks is now complete.

The primary point Groningen (Martinitoren) is considered as having been disturbed by a shifting of the foundations. The station will be determined anew from the surrounding primary stations; re-observations have so far been made at the stations Gieten, Finsterwolde and Uithuizermeden.

1.1.2 *Instruments*

The measurements are exclusively made with Wild T3 theodolits. For distances up to about 30 kilometres the signals are Bosch-Eisemann searchlights, fitted with 6 Volt, 50 Watt bulbs. For longer lines, Francis searchlights are being used, with a high pressure mercury valve as a source of light. The difficulties in automatizing the ignition of these valves have been satisfactorily solved. In the beam of this specially adapted searchlight, light intensities of about 6,000,000 candles have been measured. For compensating the sometimes very considerable voltage fluctuations, voltage stabilizers are always used.

1.1.3 *Method*

In measuring angles (by Schreiber's method) the condition is made that the results, obtained with the Wild T3 theodolite, should fit in with those, reached with the Wanschaff 35 cm theodolites in measuring the primary network. This working-method has lead to the conclusion that the formerly introduced weight of 24 can be continued.

1.1.4 *Projects*

In order to establish the connection between the new Belgian primary triangulation and the

Netherlands one, the "Institut Géographique Militaire" in Brussels was contacted; the work will be started in 1961. At the same time the Belgian base-lines of Ostende and Turnhout will be connected with the Netherlands network, like was done with the German base-line near Meppen.
In the report concerning the years 1954–1957 the necessity of re-measuring the primary network around the former Zuiderzee was mentioned. The cause is that the line Harderwijk-Enkhuizen was not observed in both directions when the triangulation was first established. It is intended to combine this work with a new determination of the primary stations Huisduinen, Schoorl and Brederode, where disturbance has occurred.
In order to obtain a homogeneous distribution of base-lines in the primary network, measurement of a new base-line in the north-western part of the country is considered.

1.2 Establishment standard base-line Loenermark, the Netherlands (Väisälä method)

In October 1957 a standard base-line of 576 m length was measured in the Loenermark near Apeldoorn by Dr. Kukkamäki and Dr. Honkasalo by means of the Väisälä method.
There are three underground bolts, at 0, 288 and 576 m. According to a report of Dr. Honkasalo the results of the measurements are, at the level of the 0-underground mark:

	distance	standard deviation
first half	288051.63 mm	0.03 mm
second half	288040.63 mm	0.03 mm
total base-line	576092.26 mm	0.05 mm

Combined with the estimated precision in the determination of the length of the quartz meters (standard deviation 0.1 μm) the standard deviation of the Loenermark base-line is to be estimated 0.08 mm, i.e. a relative precision of 1 : 7,000,000.

1.3 Triangulation and trilateration, Hydrographic Office Royal Netherlands Navy, 1957–1960

1.3.1 *The Netherlands*

The existing primary and secondary triangulation is the geodetic framework for hydrographic surveys in estuaries and along and near the coast.
Out of sight of land, positions of soundings in the North Sea are determined by radio position fixing. In the Southern part use is made of the English Decca *Navigation* chain, while moreover a Decca *Survey* chain – which has recently been established by the Ministery of Public Works – enables position fixing with an accuracy of a few meters. In the other sea areas, use is made of the far less accurate German Decca *Navigation* chain; the accuracy in this case is limited, but acceptable for the small scales at which the final charts are published.
In accordance with the national geodetic framework, the Bessel ellipsoid is used for all hydrographic computations.
The work on the determination and redetermination of conspicuous second and third order points is continued.
Work is in progress – and partly finished – to transfer all *published* charts to the European Datum (First European Adjustment).

1.3.2 *Netherlands New Guinea, Suriname and Netherlands Antilles*

There is practically no existing terrestrial triangulation, apart from third order hydrographic coastal triangulation in some areas.
The Decca Survey chain, mentioned in the 1954–1957 Report, is still in use; its transmitters will, in the near future, be moved to other sites in order to cover a new land- and sea-area. No trilateration has been carried out in the periode 1957–1960.
The ellipsoid used is the international. Various chart projections are used for the actual surveying. By international agreement all nautical charts at scales smaller than 1 : 50,000 however are *published.*
An adjustment of various overlapping third order triangulations along the Suriname river and connection to the Geodetic framework used for the aerial survey in this country, had been carried out at the Hydrographic Office.
Only minor local revisions took place in the Netherlands Antilles.

1.4 **Computing Centre, Geodetic Institute of the Technological University Delft**

The activities of the Computing Centre of the Geodetic Institute in Delft started in 1955–'56. Apart from research on numerical problems involved in geodetic adjustment, attention is directed in particular to model-assumptions in connection with precision and reliability of observations. This implies the study of fundamental problems in the adjustment theory and of the related test methods of mathematical statistics. An important feature is the study of the power function of the tests used.
Work was done on the following subjects:
Computations concerning the precision of the Netherlands primary triangulation and the connected secondary and tertiary triangulations.
Definition of the concept "precision" for triangulations and trilaterations. Careful balancing of the various approximations in the geodetic difference-relations that lead to the so-called "differential formulae of Helmert".
Methods of adjustment and unification of primary triangulations, including the study of the deformations resulting from computation on a reference ellipsoid, and the study of Laplace- and base-line equations and related equations derived by transforming differences of parallel coordinates to polar coordinates for points situated some hundreds of kilometres apart. In particular the relation between the modernized classical adjustment computation on a reference ellipsoid and the method of computation developed by Hotine.
An analysis was made of the classical model of trigonometric levelling as used for determining relative deviations of the vertical.
See also under 2.2.

Publication

J. E. ALBERDA, Vertical Angles, Deviations of the Vertical and Adjustment. Stencilled Report R 16, Computing Centre of the Delft Geodetic Institute, 1959.

2 PRECISE LEVELLING

2.1 **Precise levelling, the Netherlands, Jan. 1, 1957-Dec. 31, 1959**

2.1.1 *General information*

The Third Precise Levelling of the Netherlands, which was started in 1950, was finished in the course of 1959.
During the report period 2100 km lines of precise levelling were measured.
The total length of the network, levelled from 1950 to 1959 is 4400 km.
This network is filled up by levelling of second order: in the course of the report period about 4800 km were levelled for this purpose. Figure 2.1 is showing the network of the Third Precise Levelling.
No precise levelling is planned in the near future, unless a simultaneous remeasurement of the U.E.L.N. will be undertaken.
The filling up of the first-order network by measurements of second order will be continued.

2.1.2 *Instruments*

The instruments used in the Third Precise Levelling are:

2 Fennel "Plani"	(750 km in this period)
2 Wild N III	(550 km in this period)
1 Zeiss A	(650 km in this period)
1 Zeiss Ni-2, with rigid tripod	(150 km in this period)

All instruments are equipped with parallel plate micrometer and invar staves.
The precision with the normal first-order instruments (Fennel, Wild, Zeiss A) is $u_R = 0.58$ mm/km (standard deviation) (1950 km, 2162 discrepancies ϱ).
The results of the Zeiss Ni-2 measurements using parallelplate micrometer and invar staves have a standard deviation of $u_R = 0.64$ mm/km (150 km, 180 discrepancies ϱ).
In the second-order levelling the Zeiss Ni-2 is also used with parallel plate micrometer, but the staves are of wood instead of invar. The standard deviation of these measurements is $u_R = 0.95$ mm/km (a sample including 1100 km, 1258 discrepancies).

2.1.3 *Methods*

The methods have not been changed since the last report. The readings are taken in the sequence:

backward staff – forward staff – forward staff – backward staff or forward staff – backward staff – backward staff – forward staff. The maximum length of sight is 60 m (distance instrument to staff).

2.1.4 *Datum of the network*

The datum of the network is the "Normaal Amsterdams Peil" (N.A.P.) fixed by an underground benchmark at Amsterdam.

2.1.5 *Adjustment of the network*

The adjustment of the network is not yet completed, but the results of a preliminary adjustment are available. The differences at stable benchmarks between the second and third precise levelling are within the limits of the precision of the levellings. To obtain new heights for practical purposes the measurements of the Third Precise Levelling will be adapted to the heights of stable benchmarks of the Second Precise Levelling.
For scientific purposes (future investigations) however a free adjustment of the network will be carried out, starting from the datum point at Amsterdam.
The "scientific heights", so obtained, will not be used for practical purposes.
The only correction applied to the measurements is the orthometric correction. The precision of the Third Precise Levelling can be derived from the following data:
(see Bulletin Géodésique 1950 nr. 18 p. 525) (standard deviations)

from circuit misclosures:	$u_F = 1.03$ mm/km	
	$n_F = 41$ circuits	$F_m = 107$ km
from segment discrepancies:	$u_L = 0.88$ mm/km	
	$n_L = 124$ segments	$L_m = 35$ km
from discrepancies ϱ of intervals between consecutive benchmarks:		
	$u_R = 0.57$ mm/km	
	$n_R = 4210$ intervals	$R_m = 1.05$ km

2.1.6 *Junctions with contiguous networks*

In this period only one junction was measured, viz. Sellingen–Hasseberg. A preliminary measurement of this junction with Niedersachsen was already carried out in the period 1954–1957.
In the Third Precise Levelling 19 junctions were measured:
7 with Belgium
8 with Nordrhein-Westfalen (Deutsche Bundes Republik)
4 with Niedersachsen (Deutsche Bundes Republik)

2.1.7 *Watercrossings in the network*

A number of islands were connected to the first order levelling network by seven hydrostatic watercrossings:

across	Haringvliet	700 and 1300 m	(S.Holland)
,,	Marsdiep	3000 m	Frisian Islands
,,	Eyerlandse Gat	3000 m	Frisian Islands
,,	Vlie	6700 m	Frisian Islands
,,	Borndiep	2800 m	Frisian Islands
,,	Eilanderbalg	2400 m	Frisian Islands

Four mareographs on poles in the Zeeland estuary were connected to the levelling network by hydrostatic levelling (distances 900, 700, 1400 and 800 m).
One mareograph on a pole in the North Sea 1900 m outside the coast was also connected in this way.
For this work three armoured hoses of lead are available with length of 1450, 2250 and 3200 m. The construction is strong enough to use them many times: the 1450 m hose has been used twelve times already.
By means of special connections the hoses can be coupled so that a length of 6900 m can be obtained.
Hydrostatic levelling will be continued in 1960 and 1961.

2.1.8 *Publication*

A. Waalewijn, Report on Hydrostatic Levelling across the Westerschelde. Rijkswaterstaat Communications nr. 1, 1959. Rijkswaterstaat, Koningskade 25, The Hague, Netherlands.

2.2 **Adjustment of U.E.L.N.**

The adjustment was carried out by the Computing Centre of the Delft Geodetic Institute. The central block of U.E.L.N. was adjusted and the precision of the results was computed. Differences in mean sea level were statistically tested, including various hypotheses on mean sea level. The power of the tests used was evaluated.

Publications

Notes of the Meeting of Representatives of the Computation Offices, Delft, 28–31 January, 1959. (Stencil, Delft, 1959.)

J. E. Alberda, B. G. K. Krijger and E. F. Meerdink, The Adjustment of U.E.L.N. as Executed at Delft, Bulletin Géodésique, No. 55, 1960.


The Netherlands
Third precise levelling
1950 - 1959
underground benchmarks.
0
10
20
30
40 km
Groningen
Leeuwarden
Winschoten
Assen
Den Helder
Heerenveen
Lemmer
Meppel
Coevorden
Alkmaar
Zwolle
Haarlem
Amsterdam
Deventer
Enschede
Lochem
Amersfoort
Utrecht
'sGravenhage
Gouda
Arnhem
Aalten
Rotterdam
Nijmegen
'sHertogenbosch
Breda
Tilburg
Middelburg
Roosendaal
Eindhoven
Venlo
Roermond
Maastricht

Figure 2.1

3 GEODETIC ASTRONOMY

Temporary Geodetic-Astronomic Station at Curacao

In the beginning of 1957 a temporary geodetic-astronomic station was established at the Isle of Curaçao (Netherlands' Antilles) as one of the Netherlands' contributions to the International Geophysical Year. The operations, started August 1957 and finished January 1959, included:

1 Simultaneous determinations of Local Time, Longitude and Latitude by equal altitudes of stars, observed with the Danjon Impersonal Astrolabe.

2 Determinations of Local Time and Longitude by meridian transits of stars, observed with a classic Transit Instrument.

3 Photographing the Moon and surrounding stars with the aid of a Markowitz Moon Position Camera.

4 Determination of Corrections to Radio Time Signals by means of a specially constructed Time Signal Oscillograph.
Time keeping with three Airmec Quartz Clocks.

Observational Data of the Longitude and Latitude Determinations	Danjon Astrolabe		Transit Instr. Longitude
	Longitude	Latitude	
Number of programmes observed	261	261	167
Number of stars per programme	29	29	10
Average standard deviation of the result of a single programme, computed from the discrepancies within each individual programme ("internal accuracy")	0.0038^s	0.060″	0.0053^s
Standard deviation of the result of a single programme, computed from the discrepancies between the results of the individual programmes and the curve smoothing the results of all programmes ("external accuracy")	0.0081^s	0.100″	0.0224^s

The most striking fact is that the ratio between internal and external accuracy with the Danjon Astrolabe is considerably better than with the Transit Instrument, the proportionate numbers being 2.13 in the former and 4.23 in the latter case.
A remarkable, still unexplained phenomenon was the presence of a systematic difference between the astrolabe observations of two observers: appr. 0.005^s in local time and up to 0.10″ in latitude.

The transit observations were also affected by a singular systematic difference between the two observers; during the first two months it amounted to 0.038^s, then vanished completely and returned suddenly after four months to remain constant at 0.030^s throughout the observational period.
The Moon Position programme encountered severe difficulties because of the ever blowing trade-wind causing vibrations of the telescope. After a large wind-screen was built, circumstances improved so that 72 pictures of good quality could be produced.
The Time Signals of 14 emitting stations were checked against the Local Time, determined astronomically: Annapolis, Balboa, Belconnen, Beltsville, Buenos-Aires, Kihei, Mare Island, Moskou, Norddeich, Ottawa, Pontoise, Rio de Janeiro, Rugby and Tananarive. The total number of time signals received is 5195.

4 GRAVIMETRIC OBSERVATIONS

4.1 *General information*

Under the auspices of the Netherlands Geodetic Commission and in cooperation with the Royal Netherlands Navy 64 gravity observations have been carried out in the Pacific and 15 in the Caribbean on board of Hr. Ms. Submarine "Walrus" during November and December 1957. The Vening Meinesz apparatus was used. The results are published in "Gravity Expeditions, 1948–1958, Volume V".

The measurements for the establishment of a base-line for gravimeters, between de Bilt, the national reference station, and Eindhoven, which started in 1956, were continued. The provisional value for the gravity difference between these stations is

de Bilt (gravimeterpoint) – Eindhoven 86.08 mgal

This result is based on the value 84.64 mgal of the gravity difference between the gravimeterpoints of the base Bad Harzburg-Torfhaus.

A more accurate value of the national reference station de Bilt is available starting from the gravity value of the station Bentheim 3608A $g = 981282.40$ mgal (D.G.K. Reihe B, no. 54) and using Dutch and German measurements of the connection Bentheim 3608A – de Bilt. The provisional result is

g, de Bilt (pendulumpoint) $= 981269.42$ mgal

In "Gravity Expeditions, 1948–1958, Volume V", the old reference value of 981268.00 mgal has been used in order to avoid confusion.

There is no first order net of gravity stations in the Netherlands measured with gravimeters, but in the near future action will be taken in this direction.

4.2 *Publication*

Gravity Expeditions, 1948–1958, Vol. V, Editor G. J. Bruins. Publication of the Netherlands Geodetic Commission, Delft 1960.

5 DETERMINATION OF THE GEOID

5.1 *General information*

Up till now no computation of N has been carried out in the Netherlands and only a provisional computation of ξ_g and η_g for three stations of the primary Netherlands triangulation namely Ubagsberg, Sambeek and Oirschot, based on a gravity anomaly field with radius 600 km. Free-air anomalies were used. The computation was a provisional one because at that time the gravity field on the North Sea was unknown. As hypothesis for the gravity field of that region was accepted a zero free-air anomaly. The differences $\xi_a—\xi_g$ and $\eta_a—\eta_g$ between the astronomic and gravimetric deflections of the vertical for the three stations were

	Ubagsberg	Oirschot	Sambeek
$\xi_a—\xi_g$	$+2.05''$	$+2.30''$	$+2.44''$
$\eta_a—\eta_g$	$+0.45''$	$-0.85''$	$+0.59''$

Before long a new computation of ξ_g and η_g for the mentioned and other stations and also the computation of N will be undertaken now that gravity is known in the North Sea.

5.2 *Publications*

F. A. Vening Meinesz, The Outside Gravity Field up to Great Distance from the Earth. Koninklijke Nederlandse Akademie van Wetenschappen, Amsterdam. Proceedings Series B, 62, no. 2, 1959.

F. A. Vening Meinesz, The Results of the Development of the Earth's Topography in Spherical Harmonics up to the 31st Order; Provisional Conclusions. Koninklijke Nederlandse Akademie van Wetenschappen, Amsterdam. Proceedings Series B, 62, no. 2, 1959.