PUBLICATION OF THE NETHERLANDS GEODETIC COMMISSION

GEODETIC WORK

IN

THE NETHERLANDS

1960—1963

Report presented at the Thirteenth General Assembly of the International Association of Geodesy at Berkeley 1963

1 TRIANGULATION

1.1 **Primary triangulation, the Netherlands, 1960—1963**

1.1.1 *General information*

In 1960 two new first-order intermediate points (Lichtmis and Lutten) were determined in the area of the boundary between the parts I and III of the primary triangulation network. These two points form a chain of triangles with the primary stations Steenwijk, Ruinen, Beilen, Sleen, Uelsen, Lemelerberg and Kampen. By adding these two intermediate points to the first-order network a better determination of the secondary stations in this area becomes possible.

	Year of measurement			
	1894/96	1961/62		
STATION	M_x^2	M_x^2	$3m_v$	Direction after adjustment of the net
Direction to:	Directions reduced to centre		1894/6—1961/2	
WESTKAPELLE	0.0672	0.2133	2.24	
Westerschouwen	0.0000.00	0.0000.00		0.0000.00
Middelburg	72.8807.54	72.8809.96	−2.42	72.8806.37
Aardenburg	155.2521.33	155.2520.10	+1.23	155.2520.46
AARDENBURG	0.0581	0.1291	1.83	
Westkapelle	0.0000.00	0.0000.00		0.0000.00
Middelburg	27.5431.70	27.5429.36	+2.34	27.5431.30
Assenede (B.)	114.7616.54	114.7616.35	+0.19	114.7615.65
HULST	0.3692	0.4183	3.76	
Bergen op Zoom	0.0000.00	0.0000.00		0.0000.00
Assenede (B.)	244.6457.73	244.6462.83	−5.10	244.6459.32
BERGEN OP ZOOM	0.2269	0.0333	2.16	
Hoogstraten (B.)	0.0000.00	0.0000.00		0.0000.00
Hulst	119.0113.38	119.0113.06	+0.32	119.0113.79
LUYKSGESTEL	0.3959	0.0717	2.90	
Peer (B.)	0.0000.00	0.0000.00		0.0000.00
Hoogstraten (B.)	150.4917.66	150.4917.28	+0.38	150.4915.18

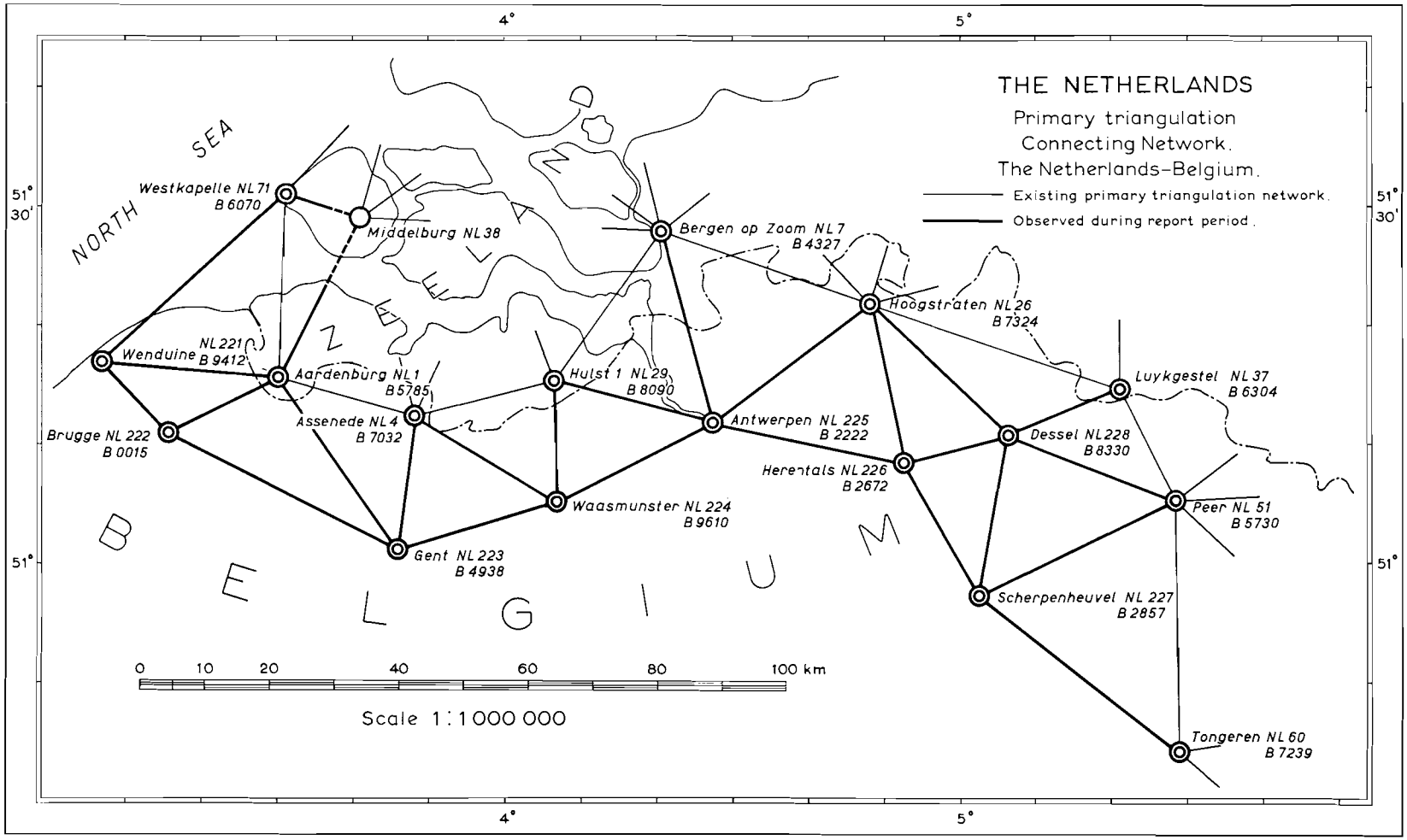
THE NETHERLANDS
Primary triangulation
Connecting Network.
The Netherlands–Belgium.
Existing primary triangulation network.
Observed during report period.
NORTH SEA
NETHERLANDS
BELGIUM
4°
5°
51° 30'
51°
Westkapelle NL 71 B 6070
Middelburg NL 38
Bergen op Zoom NL 7 B 4327
Hoogstraten NL 26 B 7324
Wenduine NL 221 B 9412
Aardenburg NL 1 B 5785
Hulst 1 NL 29 B 8090
Luykgestel NL 37 B 6304
Assenede NL 4 B 7032
Antwerpen NL 225 B 2222
Brugge NL 222 B 0015
Dessel NL 228 B 8330
Herentals NL 226 B 2672
Waasmunster NL 224 B 9610
Peer NL 51 B 5730
Gent NL 223 B 4938
Scherpenheuvel NL 227 B 2857
Tongeren NL 60 B 7239
0 10 20 40 60 80 100 km
Scale 1 : 1 000 000

Figure 1.1

In collaboration with the "Institut Géographique Militaire" in Brussels a start was made with the connection between the Netherlands and Belgian primary triangulation networks. The only place where some difficulties were encountered during the reconnaissance was Luyksgestel due to the low steeple. The stations Aardenburg, Assenede, Hulst, Hoogstraten and Middelburg (the latter lying outside the actual connecting network) were badly damaged by war activities during the years 1940–1945. But in the ruins of the buildings some old reference marks were found and starting from these marks an attempt was made to preserve these stations. However, it is still questionable how far this effort has succeeded. This refers particularly to the stations Middelburg and Hoogstraten which were very badly damaged and of which only one single reference mark was found again in the very unreliable remnants of the walls.
The table on page 1 shows a comparison between a number of angles observed when the original measurements were performed in the years 1894–1896 and the same angles measured again when the connecting measurements were carried out in 1961–1962. From the measurements at the stations Westkapelle and Aardenburg it appears that indeed a disturbance of the primary station Middelburg must be taken into consideration. The large difference occuring at the station Hulst cannot be completely explained by observational inaccuracies. The action to be taken in this case will depend on the results of the Belgian measurements referring to this station.
In 1962 a start was made with the reconnaissance and the measuring of a network of first-order intermediate points in Netherlands and Belgian Limburg in the area between the primary stations Peer, Tongeren, Battice, Langschoss, Ubachsberg, Klifsberg and Nederweert, again in collaboration with the "Institut Géographique Militaire" in Brussels. The object of this work is to arrive at a redetermination of the previously very poorly determined intermediate point Echt and a redetermination of the intermediate point Sittard which has become unreliable owing to mining in this area. At the same time these measurements will be used for connecting the Belgian secondary network to the Netherlands network.

1.1.2 *Instruments*

The measuring of directions for the first-order network is always carried out according to the method of Schreiber and using a Wild T3 theodolite. For the primary directions a weight of 24 was applied and for the intermediate points a weight of 12 was used.

1.2 **Base measuring**

In 1960 a survey crew of the Netherlands Triangulation Service participated in the remeasuring of the old German base near Meppen.

1.3 **Triangulation and trilateration, Hydrographic Office Royal Netherlands Navy, 1960—1963**

1.3.1 *The Netherlands*

The existing primary and secondary triangulation is the geodetic framework for hydrographic surveys in the 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, using the Decca *Navigator* System. Whenever possible, radio positioning is checked against

geodetic position fixing. In the Southern part, use is made of a Decca *Survey* chain established in 1958 by the Ministry of Public Works enabling position fixing with an accuracy better than the plotting accuracy on the scale of the chart, being for nautical charts 1:20,000 or smaller. In accordance with the national framework, the Bessel ellipsoid is used for all hydrographic computations.
The work on determination and redetermination of conspicuous second and third order points is continued.
Nearly all *published* nautical charts have by now been transferred to the European datum (first adjustment) and international ellipsoid.

1.3.2 *New Guinea, Surinam and Netherlands Antilles*

There is practically no existing triangulation, apart from third order hydrographic coastal triangulation in some areas.
The Decca *Survey* Chain, mentioned in the 1954–1957 and 1957–1960 Reports, has in 1962 been moved to new positions. The sides, of 180, 200 and 320 km respectively, formed by this new triangle were measured by the Decca system itself, their length thus being expressed in wave-lengths. The closing error was 0.03 lanes, corresponding with approximately 15 metres. Although a very good result for this type of trilateration, the actual length of the sides can be computed approximately only because of insufficient knowledge of the propagation speed of the radio waves.
The Decca survey in New Guinea was terminated in 1962 and plans are in preparation to continue it in Surinam.
The ellipsoid used for hydrographic surveys outside the home country is the international one. Various chart projections are used for the actual survey. By international agreement all nautical charts at scales smaller than 1 : 50,000 however are *published* in the Mercator projection.

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

Experimental measurements with the Tellurometer and the Geodimeter NASM-4A were made to obtain basic statistical information and to gain experience in the establishment of lower-order control with these instruments.
Within the framework of Special Study Group No. 14 an analysis was made of the concept Strength of Figure.
See also under 2.2.

Publications

D. DE GROOT, Ten-place Trigonometric Tables in the Sexagesimal and the Decimal System. Netherlands Geodetic Commission, Delft, 1961.
J. E. ALBERDA, Vertical Angles, Deviations of the Vertical and Adjustment. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Volume 1, No. 1, Delft, 1961.
W. BAARDA, A Generalization of the Concept Strength of Figure. Stencilled Report, Computing Centre of the Delft Geodetic Institute, 1962.

2 PRECISE LEVELLING

2.1 **Precise levelling, the Netherlands, January 1st, 1960 — December 31th, 1962**

2.1.1 *General information*

The Third Precise Levelling of the Netherlands was completed in 1959. During the report period only 90 km of first-order levelling was measured. The filling-up of the network by second-order levelling was completed in the course of the period. For this purpose about 3700 km were measured.

2.1.2 *Instruments*

Besides the instruments mentioned in the previous report (Fennel Plani, Wild N III, Zeiss A en Zeiss Ni-2) the Jena Koni 007 automatic instrument was used with good results. (Standard deviation $U_R = 0.53$ mm estimated from 47 discrepancies ϱ.)

2.1.3 *Methods*

The methods have not been changed since the previous report.

2.1.4 *Datum of the network*

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

2.1.5 *Adjustment of the network*

The adjustment of the Third Precise Levelling was carried out by the Computing Centre of the Delft Geodetic Institute. The 58 normal equations were solved with help of an electronic computer (ZEBRA). The precision according to this adjustment follows the following estimated standard deviation: $u_{f_\gamma} = 1.1$ mm.
The results of this adjustment were only slightly different from the results of the preliminary adjustment mentioned in the previous report. They are only used for scientific purposes; new heights for practical purposes were obtained by keeping the old heights of a number of stable benchmarks fixed, and using the new measurements for the computation of the new heights of the remaining benchmarks, making local adjustments.

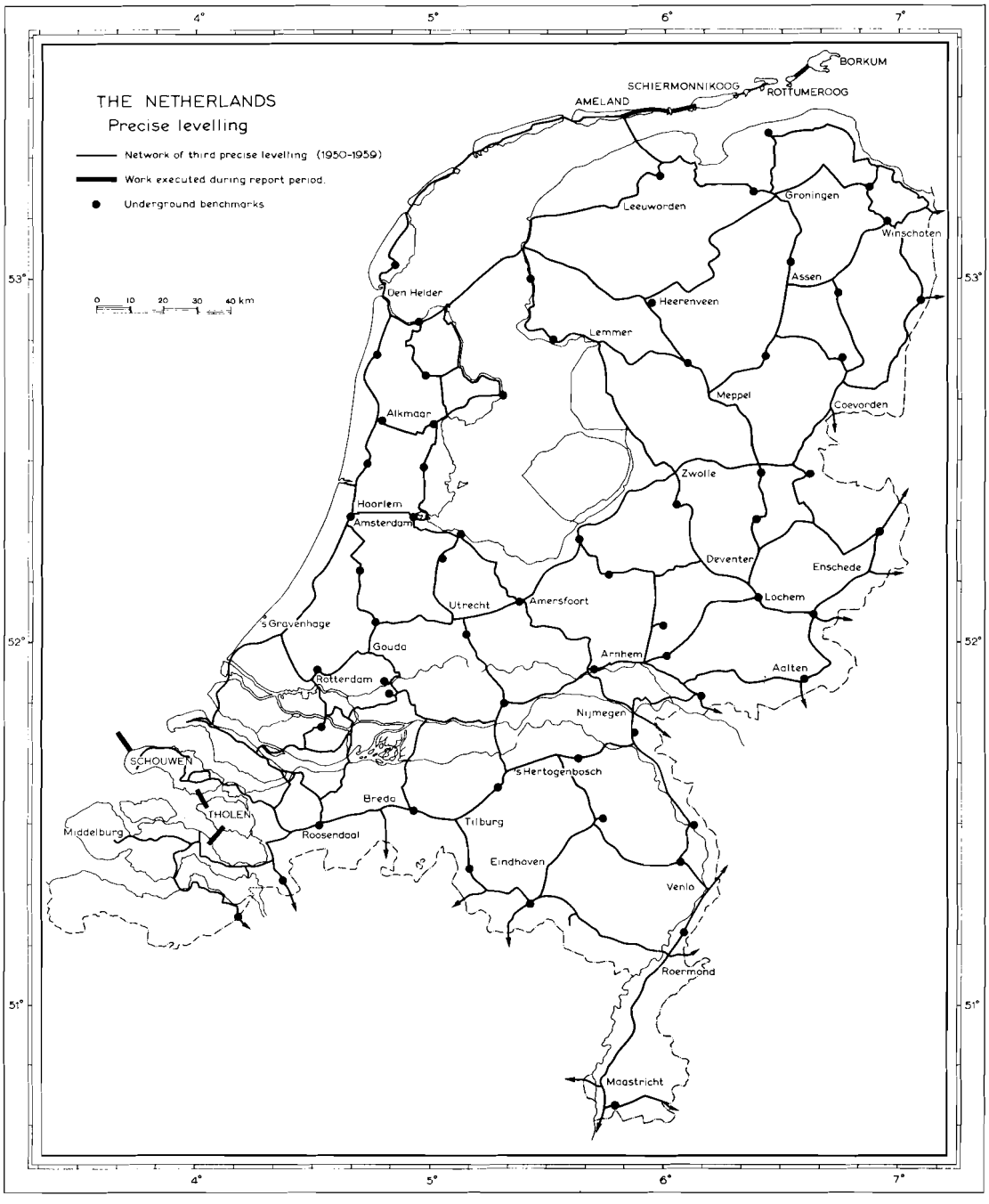
THE NETHERLANDS
Precise levelling
Network of third precise levelling (1950-1959)
Work executed during report period.
Underground benchmarks
0 10 20 30 40 km
4°
5°
6°
7°
53°
52°
51°
BORKUM
SCHIERMONNIKOOG
ROTTUMEROOG
AMELAND
Leeuwarden
Groningen
Winschoten
Assen
Heerenveen
Den Helder
Lemmer
Meppel
Coevorden
Alkmaar
Zwolle
Haarlem
Amsterdam
Deventer
Enschede
Utrecht
Amersfoort
Lochem
's Gravenhage
Gouda
Arnhem
Aalten
Rotterdam
Nijmegen
SCHOUWEN
's Hertogenbosch
Breda
THOLEN
Middelburg
Roosendaal
Tilburg
Eindhoven
Venlo
Roermond
Maastricht

Figure 2.1

2.1.6 *Junctions with contiguous networks*

A junction from the island of Rottumeroog to the island of Borkum (Germany) was measured by hydrostatic levelling in 1960. This junction has no influence on the relative position of N.A.P. (Netherlands datum) and N.N. (German datum), but it offered a good check on the benchmarks in both islands, which take up a rather isolated position in the national networks.

2.1.7 *Special measurements*

Hydrostatic levelling was continued in the period of this report. A length of 7200 m lead hose is available.
The levelling of the Frisian Islands was extended by a hydrostatic connection between Ameland and Schiermonnikoog (across Pinkegat and Zoutkamperlaag). The connection Rottumeroog–Borkum (Germany) across the Westerems (5.4 km) was also measured by hydrostatic levelling.
Two smaller hydrostatic levellings connected the island of Tholen with the adjacent islands of Schouwen and Zuid-Beveland.
A recording tide-gauge on an observation post in the North Sea, 7.2 km off the coast of the island Schouwen was levelled by hydrostatic levelling in November 1961.
At the request of "Wasser- und Schiffahrtsdirektion Hamburg" a hydrostatic levelling of 7.2 km was performed across the Aussenelbe (Elbe estuary) North of the island Neuwerk in June 1962.

2.1.8 *Publications*

A. WAALEWIJN, Toepassing van hydrostatische waterpassing in Nederland. Geodesia 1961, p. 27.
JOH. VAN VEEN en A. WAALEWIJN, Bodemdaling en daling van dijkkruinen ten opzichte van de gemiddelde zeespiegel. Rapport Deltacommissie. Staatsdrukkerij en Uitgeverijbedrijf, 's-Gravenhage 1961.
A. WAALEWIJN, Das Hydrostatische Nivellement Borkum–Rottumeroog. Zeitschrift für Vermessungswesen 1961, p. 116.
A. WAALEWIJN, Crustal Movements in the Netherlands (Brief Communication). Bulletin Géodésique 1961, p. 369.
A. WAALEWIJN, Rapport Général no. 2 sur les Nivellements de Précision 1957–1959. Travaux de l'Association Internationale de Géodésie, Tome 21, p. 103, Paris 1962.

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

The final report on the adjustment of the U.E.L.N. as executed by the Computing Centre of the Delft Geodetic Institute will be published in the course of this year.

Publications

J. E. ALBERDA, Report on the Adjustment of the United European Levelling Net and Related Computations. Netherlands Geodetic Commission, Publications on Geodesy, New Series, Volume 1, No. 2, Delft, 1963.

3 GEODETIC ASTRONOMY

Temporary Geodetic-Astronomic Station at Curaçao

3.1 *General information*

In connection with the International Geophysical Year observations were carried out at this station from July 1957 to January 1959. A brief discussion of the work done and the results obtained has been given in "Geodetic Work in the Netherlands, 1957–1960".
The methods applied, an analysis of the results and a discussion of an observed source of error of the Danjon Impersonal Astrolabe are described in detail in a publication of the Netherlands Geodetic Commission (3.2).

3.2 *Publications*

A. C. SCHEEPMAKER, Analyse van de waarnemingsresultaten verkregen op het geodetisch-astronomisch station op Curaçao tijdens het Internationaal Geophysisch Jaar 1957–1958 en een onderzoek van het astrolabium A. Danjon (with a résumé in French: Analyse des résultats des observations faites à Curaçao pendant l'Année Géophysique Internationale 1957–1958 et recherches effectuées sur l'astrolabe A. Danjon). Netherlands Geodetic Commission, Publications on Geodesy, New Series, Volume 1, No. 4, Delft, 1963.

4 GRAVIMETRIC OBSERVATIONS AND COMPUTATIONS

4.1 *General information*

During the years 1960–1962 a new primary gravity net was measured in the Netherlands by the Delft Geodetic Institute. The instruments which have been used for this project were an Askania Gs 9, a Worden "Master" and three North American gravimeters. All instruments were calibrated on the German part of the European gravity base so that all gravity values are expressed in the European milligal.

The gravity network, consisting of 52 stations, is connected with the German network at the stations Leer, Bentheim, Wesel and Düren. The gravity differences between these stations were included in the adjustment of the Netherlands network. It appeared from the small corrections applied to these differences that there is no evidence of a scale difference between the Netherlands and German gravity nets. The circuits which include the Belgian primary gravity stations Brugge, Antwerpen, Lommel, Tongeren and Baraque Michel were measured early 1963.

The terminal stations de Bilt and Eindhoven of the old gravity calibration base in the Netherlands form part of the new network although for practical reasons, the measurements were made at new excentric stations, close to the old ones. The small gravity differences between the old and new locations were separately measured; they are for De Bilt and Eindhoven -0.25 mgal and $+0.16$ mgal respectively.

The new measurements result in a gravity difference of 86.08 mgal between the old base stations which is exactly the same value as the value found previously (see Geodetic Work in the Netherlands 1957–1960, Section 4).

The base De Bilt–Eindhoven will no more be used as a calibration base; as such it is replaced by a base between Amstelveen and Eindhoven because transportation between these stations is more convenient. This new base covers also a greater gravity difference namely 105.15 mgal.

The location of the station at the airport of Schiphol has been chosen on the airfield side of the customs area in order to facilitate international gravimeter measurements by airplane.

Figure 4.1 shows the observed as well as the adjusted gravity differences between the main stations of the network.

Under auspices of the Royal Meteorological Institute at De Bilt gravity measurements were also carried out in Surinam (1960, 325 stations), British Guyana (1960, 25 stations) and on the Dutch Antilles Aruba, Bonaire and Curaçao (1962, 100 stations). The measurements were carried out with an Askania Gs 9, a Worden and a North American gravimeter. The latter two instruments were placed at the disposal of the Royal Meteorological Institute by the Bataafsche International Petroleum Company.

In 1962 the Delft Geodetic Institute participated in the adjustment of the European gravity net. These computations were carried out in cooperation with the German Geodetic Institute at Munich and the National Physical Laboratory at Teddington.

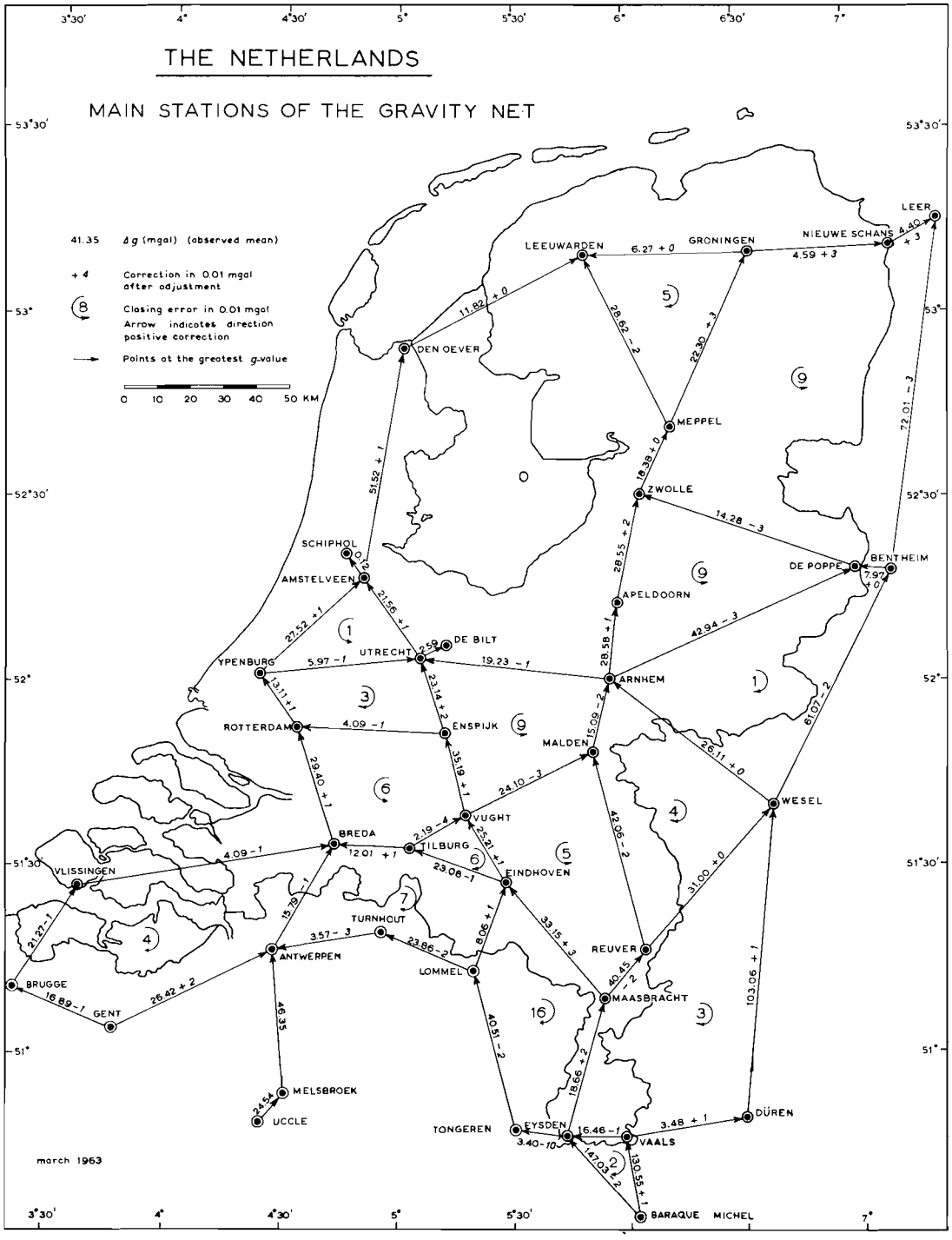
THE NETHERLANDS
MAIN STATIONS OF THE GRAVITY NET
41.35 Δg (mgal) (observed mean)
+4 Correction in 0.01 mgal after adjustment
8 Closing error in 0.01 mgal
Arrow indicates direction positive correction
Points at the greatest g-value
0 10 20 30 40 50 KM
DEN OEVER
LEEUWARDEN
GRONINGEN
NIEUWE SCHANS
LEER
MEPPEL
ZWOLLE
SCHIPHOL
AMSTELVEEN
DE BILT
UTRECHT
YPENBURG
APELDOORN
DE POPPE
BENTHEIM
ARNHEM
ROTTERDAM
ENSPIJK
MALDEN
WESEL
VUGHT
BREDA
TILBURG
EINDHOVEN
VLISSINGEN
TURNHOUT
REUVER
ANTWERPEN
LOMMEL
MAASBRACHT
BRUGGE
GENT
MELSBROEK
UCCLE
TONGEREN
EYSDEN
VAALS
DÜREN
BARAQUE MICHEL
march 1963

Figure 4.1

The importance of having maps with mean elevations and gravity-anomalies has been stressed in a resolution adopted at the 11th Assembly of the A.I.G. in Toronto 1957. The Delft Geodetic Institute has published these maps for the Netherlands showing mean elevations, Bouguer and free-air anomalies for grid squares of 3′ lat. by 5′ longt.

4.2 *Publications*

Maps of mean elevations, free-air and Bouguer anomalies for a grid of 3′ lat. by 5′ longt. Delft Geodetic Institute, 1963.

5 DETERMINATION OF THE GEOID

5.1 *General information*

The gravity measurements in Surinam (see Section 4) revealed a rather irregular anomaly field. A tentative computation of relative deflections of the vertical at four astro-stations led to a maximum value of 12″ for the difference in the east-west components of two stations situated 70 km apart.