PUBLICATION OF THE NETHERLANDS GEODETIC COMMISSION

GEODETIC WORK

IN

THE NETHERLANDS

1954—1957

Report presented at the Eleventh General Assembly of The International Association of Geodesy at Toronto 1957

1 TRIANGULATION

1.1 **Primary triangulation, the Netherlands, 1954-1957**

1.1.1 *General information*

In this period of report the following objects in the domain of first order triangulation have been taken up:

Network of the Zuiderzee In the original triangulation of the Netherlands the direction Enkhuizen-Harderwijk has not been measured, because of the insufficient height of the church of Harderwijk. The reclaim of the Zuiderzee made it possible to fill up this gap and a simple central network has been measured with Lelystad as a central point.

Northern junction network with Germany Between the triangulations of the Netherlands and Germany there was a gap in the area between Finsterwolde and Oldenzaal-Bentheim. In co-operation with the "Niedersächsisches Landesvermessungsamt" in Hannover a reconnaissance has been made and a triangulation network designed, which is to be measured in 1957, also in co-operation with the German officers.

Southern connection network with Germany The southern connection with Germany has not been measured completely in former days. The observations of the central point Kevelaer are lacking. At a conference with the German officers of the "Landesvermessungsamt Nordrhein-Westfalen" it has been decided to measure the lacking observations in co-operation in 1957.

1.1.2 *Instruments*

The measurements are carried out with the Wild T3. The observations are performed by daylight and by pointing on Francis searchlights with a diameter of 10 inches, which have an intensity of light of 100,000 candles, and on Bosch-Eisemann searchlights with a candle-power of 250,000. At present the Francis searchlights are to be fitted out with Philips mercury valves with advanced ignition apparatus, by which the intensity of light increases to 5000,000 candles.

1.1.3 *Method*

The new observations are carried out after the method of SCHREIBER with the modification given by BRADFORD. The judgment of the observations is performed after the method indicated by H. WOLF, after correction for the periodical error of the circle, and with tolerances derived from the original observations of the first order network of the Netherlands. So the difference between the measurements of each angle is not allowed to surpass 5.6 centesimal seconds (after

correction for the periodical error). The standard deviation of the single observation of the original measurements with the Wanschaff 35 cm theodolite was 3.0 centesimal seconds, while the standard deviation of the new observations with the Wild T3 is 3.4 centesimal seconds.

1.1.4 *Projects*

A project has been made to connect the Netherlands triangulation with the new Belgian network. This will also provide a link between the Netherlands network and the Belgian base-line near Brugge.
In addition to the German base-line near Meppen, which will be connected to the Netherlands triangulation by way of above mentioned northern junction network, we have at our disposal the base-lines of Stroe, Bonn and Brugge. For a good distribution the measuring of base-lines in the north-western and eastern part of the country is desirable.
An investigation will be made into the stability of the south-eastern part of the Netherlands triangulation network, where landslide owing to mining has been observed.
In addition to the astronomic observations mentioned in the publication of the Netherlands Geodetic Commission "Geodetic Work in the Netherlands 1940-1953" an astronomic determination of azimut is planned at Goedereede, to complete the astronomic observations at this station.
The measuring of a pair of Laplace-stations in the centre of the country, for instance Utrecht-Amersfoort, is desirable.
For all above mentioned projects we refer to Figures 1.1.4a and 1.1.4b.

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

In its session of May, 13th, 1955 the Netherlands Geodetic Commission, in pursuance of a letter dated February 3rd, 1955 from the Central Bureau of the International Association of Geodesy, decided to establish a standard base-line for calibrating invartapes and geodimeters, by means of the Väisälä-method, for the purpose of assuring an international uniform scale in her own triangulation and in those of North-West Europe.
The Commission decided to ask the Finnish Geodetic Institute, in accordance with a letter from its Director Prof. dr. W. HEISKANEN, dated January 15th, 1955 to Professor TARDI, to put the Väisälä-comparator and a staff of experienced scientists at their disposal to carry out this work, which request was generously granted.
After a thourough inspection to find out which part of the Netherlands was most suitable for the base-line from a geological and soil-mechanical point of view, a terrain of moraine-soil was chosen in the Loenermark near Apeldoorn (see Figure 1.2).
Thereafter, in consultation with Dr. KUKKAMÄKI of the Finnish Geodetic Institute, more detailed plans were made. The length of the base-line was determined to be 576 m as the measurement of a greater length would be difficult to realise, due to unfavourable weatherconditions in the Netherlands, and pillars were built at 0–1 m, 6, 24, 96, 288 and 576 m. The measurement of the base-line by Dr. KUKKAMÄKI and Dr. HONKASALO will take place in October 1957.

1.3 **Triangulation and trilateration, Hydrografic Office Royal Netherlands Navy, 1954-1957**

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 means of the German Decca Navigation chain; the accuracy is limited, but acceptable for the small scales on which the final charts are published.
Work has been established on:

- *a* Determination and redetermination of conspicuous second and third order points.
- *b* Computation and publication through the International Hydrographic Bureau in Monaco of 22 first and second order "Coastal" points in the system of the first European adjustment, to be used as part of the general framework for unification of all nautical charts of European waters on the European datum.
- *c* Preliminary computations, for planned transfer of all nautical charts of the Netherlands to European datum.
- *d* Derivation of formulae for connecting Belgian to Netherlands primary triangulations in the area of the estuary of the river Scheldt.

1.3.2 *Neth. New Guinea, Suriname and Neth. Antilles*

There is practically no existing terrestrial triangulation, apart from old third order hydrographic coastal triangulation in some areas.
A Decca Survey chain, covering an area sea and land of 250 × 400 kilometres, has been set up in New Guinea in 1956. The ellipsoid used is the international. By international agreement projection of nautical charts will be Mercator; U.T.M. projection will be used for maps.
The following work has been carried out:

- *a* The Decca chain itself has been used for measuring distances, because no terrestrial triangulation was available *).
- *b* Control measurements by first order traverse *).
- *c* Preliminary work on trilateration *).
- *d* First order invar taped base-line at Merauke New Guinea.
- *e* Third order local surveys in other areas of New Guinea.

The three sides of triangle KEM in Figure 1.3.2 have been measured by Decca; closing error in this triangle is 23 metres. In future, the Decca transmitters will be moved to other sites and the distances indicated by the dotted lines also will be measured by Decca and therefore by then will constitute a network of trilateration.
The base-line Merauke of 470 metres has been measured by two invartapes calibrated in Helsinki. The interval accuracy was 1 part in 1.6×10^6. The swampy surrounding terrain prevented maintaining high order accuracy in the local terrestrial triangulation in this area.

*) Detailed reports by J. TH. VERSTELLE will be presented at the General Assembly in Toronto.

THE NETHERLANDS

BASE EXTENSION NETWORK

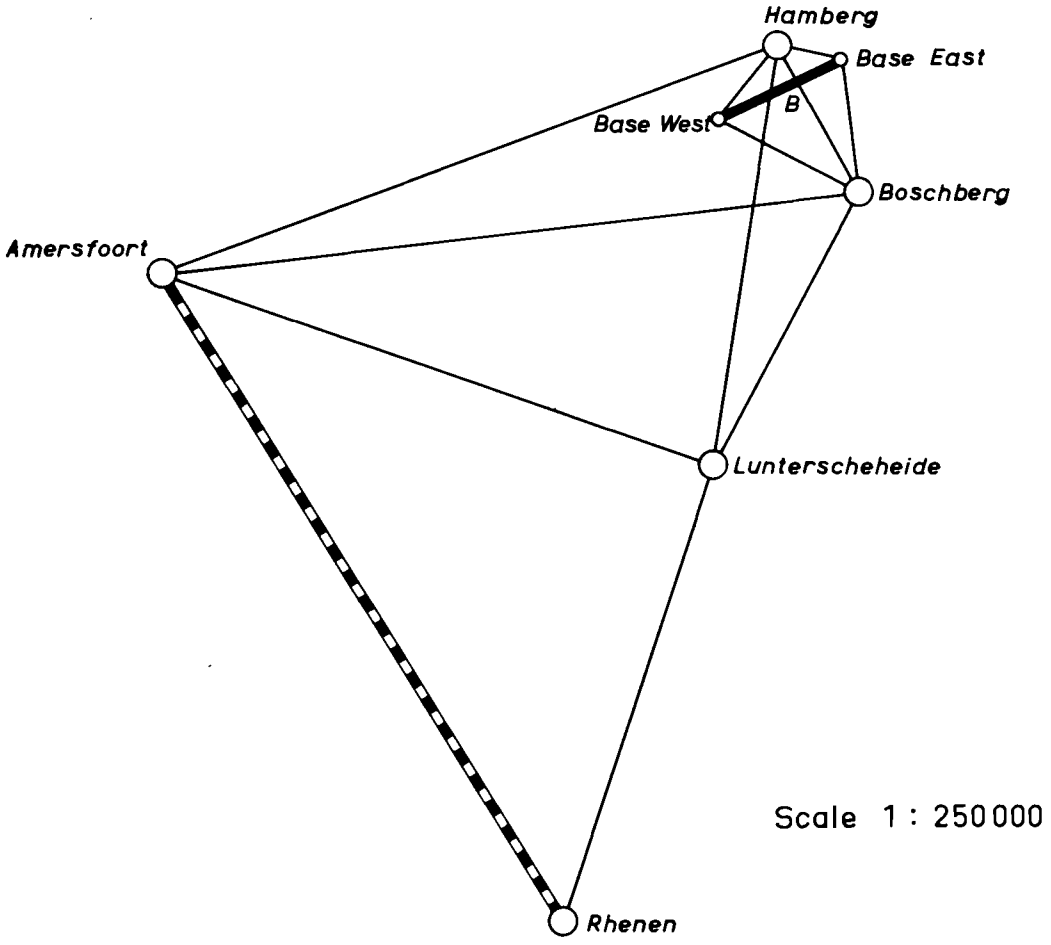
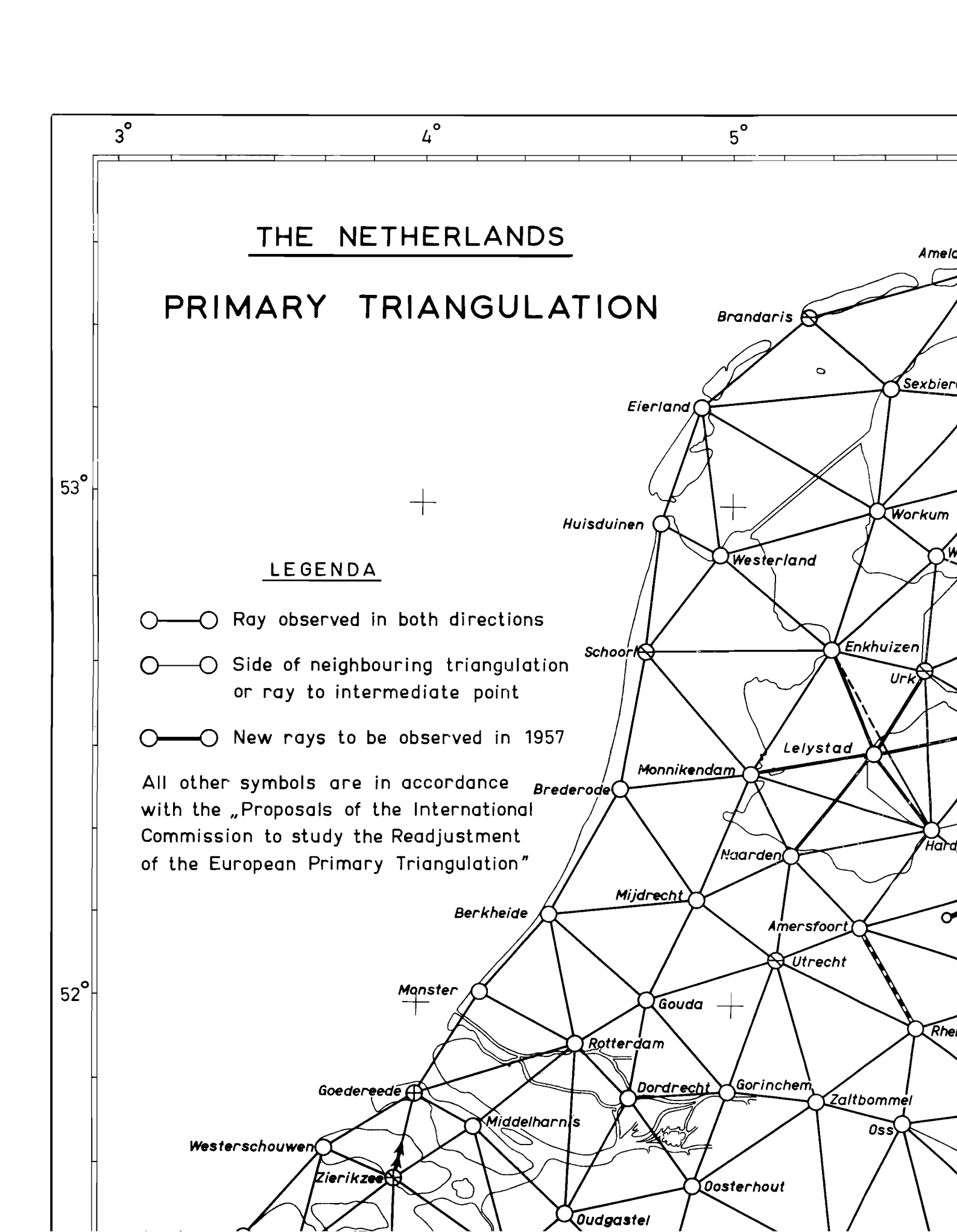
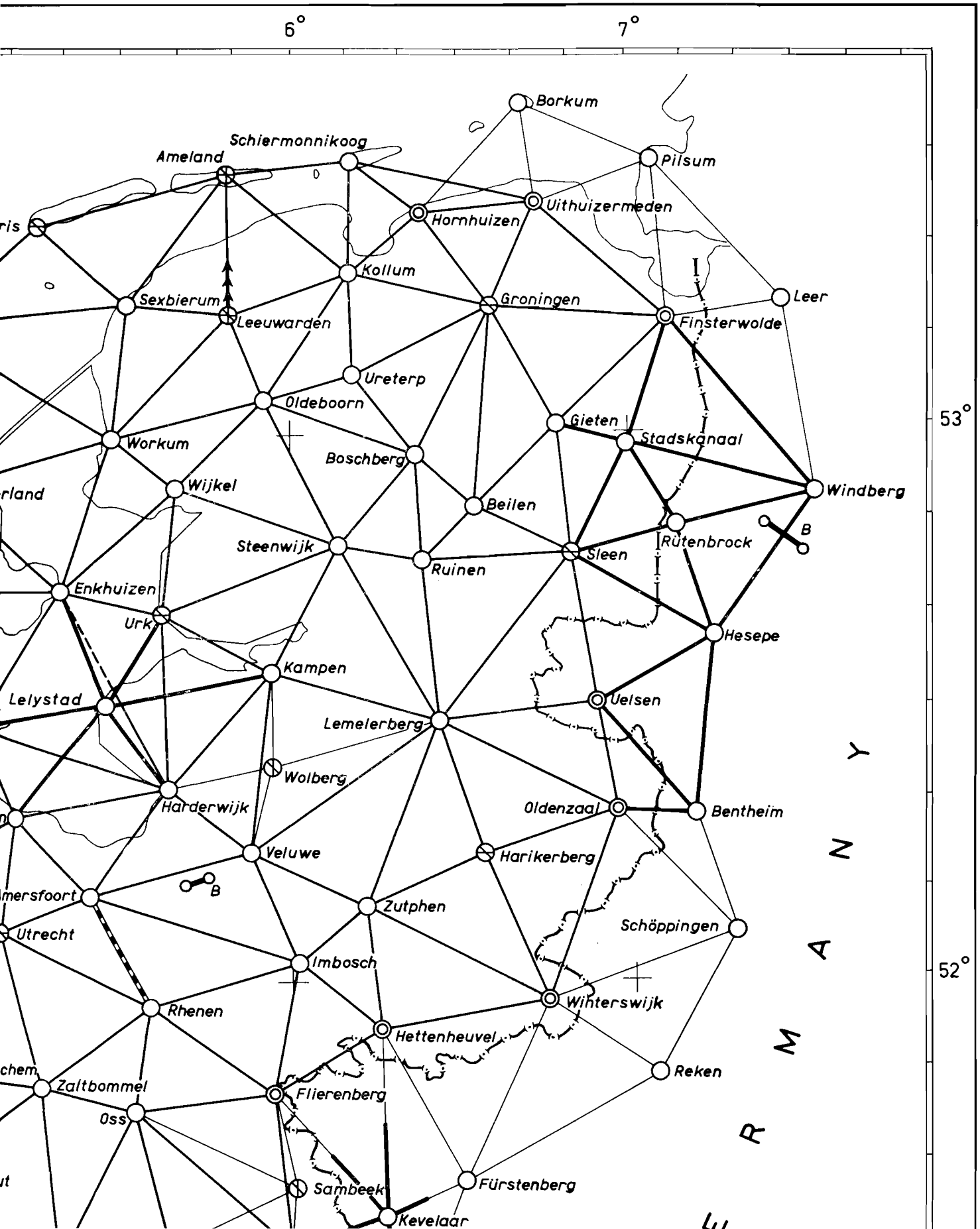


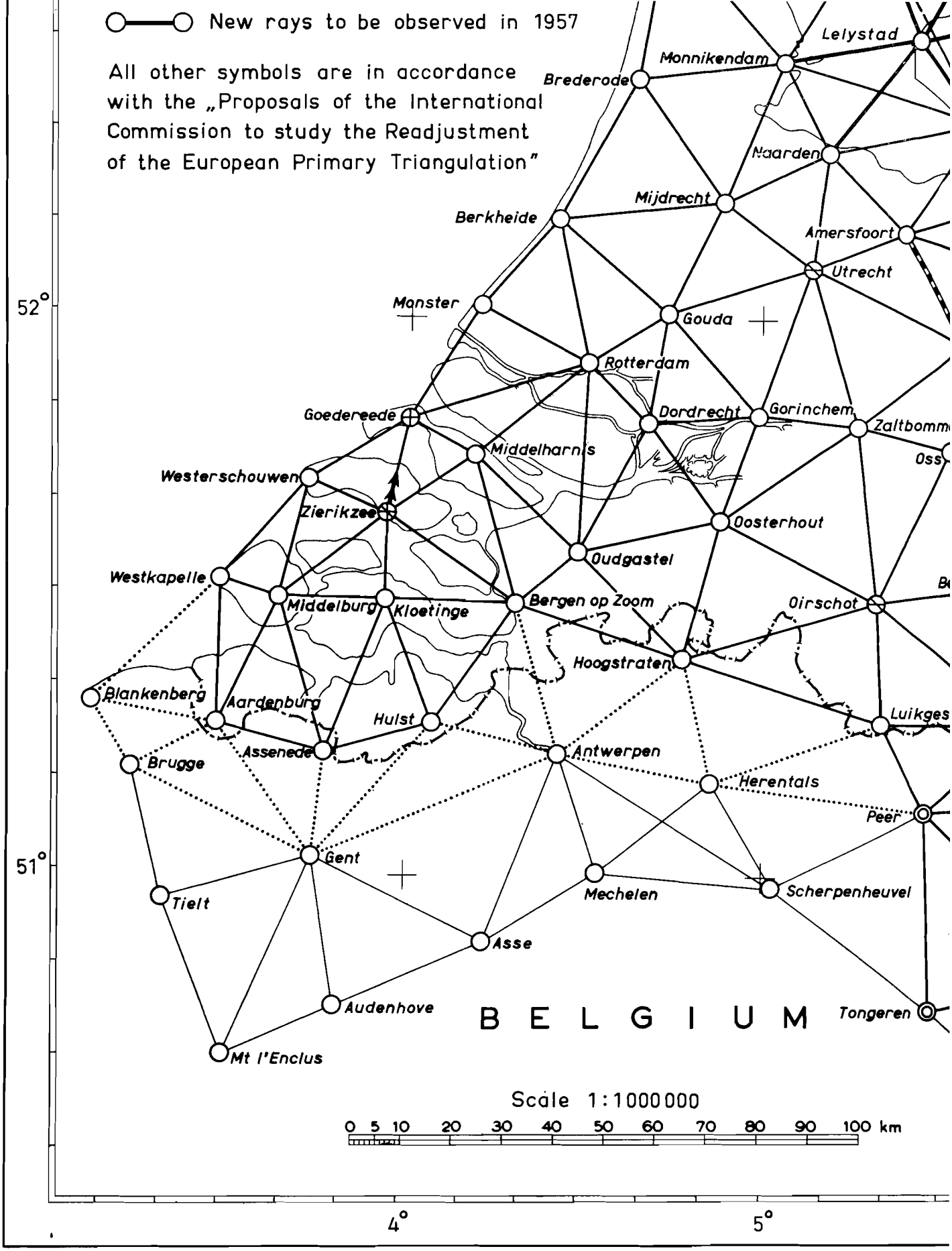
Fig. 1.1.4b

THE NETHERLANDS

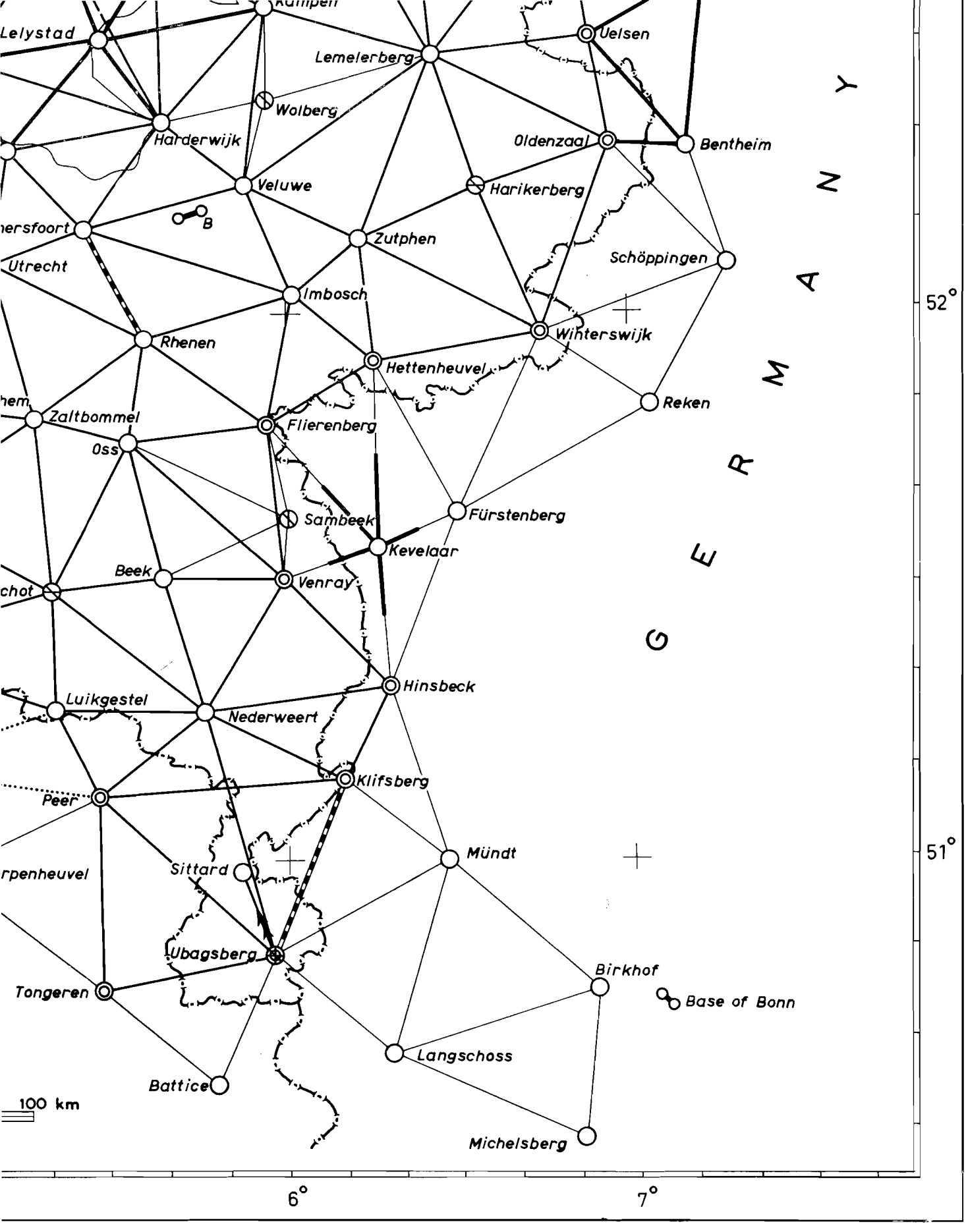
PRIMARY TRIANGULATION




6°
7°
53°
52°
Borkum
Schiermonnikoog
Ameland
Pilsum
Uithuizermeden
Hornhuizen
Kollum
Sexbierum
Leeuwarden
Groningen
Leer
Finsterwolde
Ureterp
Oldeboorn
Gieten
Stadskanaal
Workum
Boschberg
Wijkel
Beilen
Windberg
Rütenbrock
B
Steenwijk
Sleen
Ruinen
Enkhuizen
Urk
Hesepe
Kampen
Lelystad
Uelsen
Lemelerberg
Wolberg
Harderwijk
Oldenzaal
Bentheim
Veluwe
Harikerberg
B
Zutphen
Schöppingen
Utrecht
Imbosch
Rhenen
Winterswijk
Hettenheuvel
Reken
Zaltbommel
Flierenberg
Oss
Sambeek
Fürstenberg
Kevelaar
R M A N Y


New rays to be observed in 1957
All other symbols are in accordance with the „Proposals of the International Commission to study the Readjustment of the European Primary Triangulation"
Lelystad
Monnikendam
Brederode
Naarden
Mijdrecht
Berkheide
Amersfoort
Utrecht
Monster
Gouda
Rotterdam
Goedereede
Dordrecht
Gorinchem
Middelharnis
Westerschouwen
Zierikzee
Oosterhout
Oudgastel
Westkapelle
Middelburg
Kloetinge
Bergen op Zoom
Oirschot
Hoogstraten
Blankenberg
Aardenburg
Hulst
Assenede
Antwerpen
Brugge
Herentals
Peer
Gent
Tielt
Mechelen
Scherpenheuvel
Asse
Audenhove
Mt l'Enclus
BELGIUM
Tongeren
52°
51°
4°
5°
Scale 1:1000000
0 5 10 20 30 40 50 60 70 80 90 100 km

Fig, 1.1.4a


Lelystad
Lemelerberg
Uelsen
Wolberg
Harderwijk
Oldenzaal
Bentheim
Veluwe
Harikerberg
B
Zutphen
Schöppingen
Utrecht
Imbosch
Winterswijk
Rhenen
Hettenheuvel
Reken
Zaltbommel
Flierenberg
Oss
Sambeek
Fürstenberg
Kevelaar
Beek
Venray
Hinsbeck
Luikgestel
Nederweert
Klifsberg
Peer
Mündt
Sittard
Ubagsberg
Birkhof
Tongeren
Base of Bonn
Langschoss
Battice
Michelsberg
GERMANY
52°
51°
6°
7°
100 km

Fig, 1.1.4a

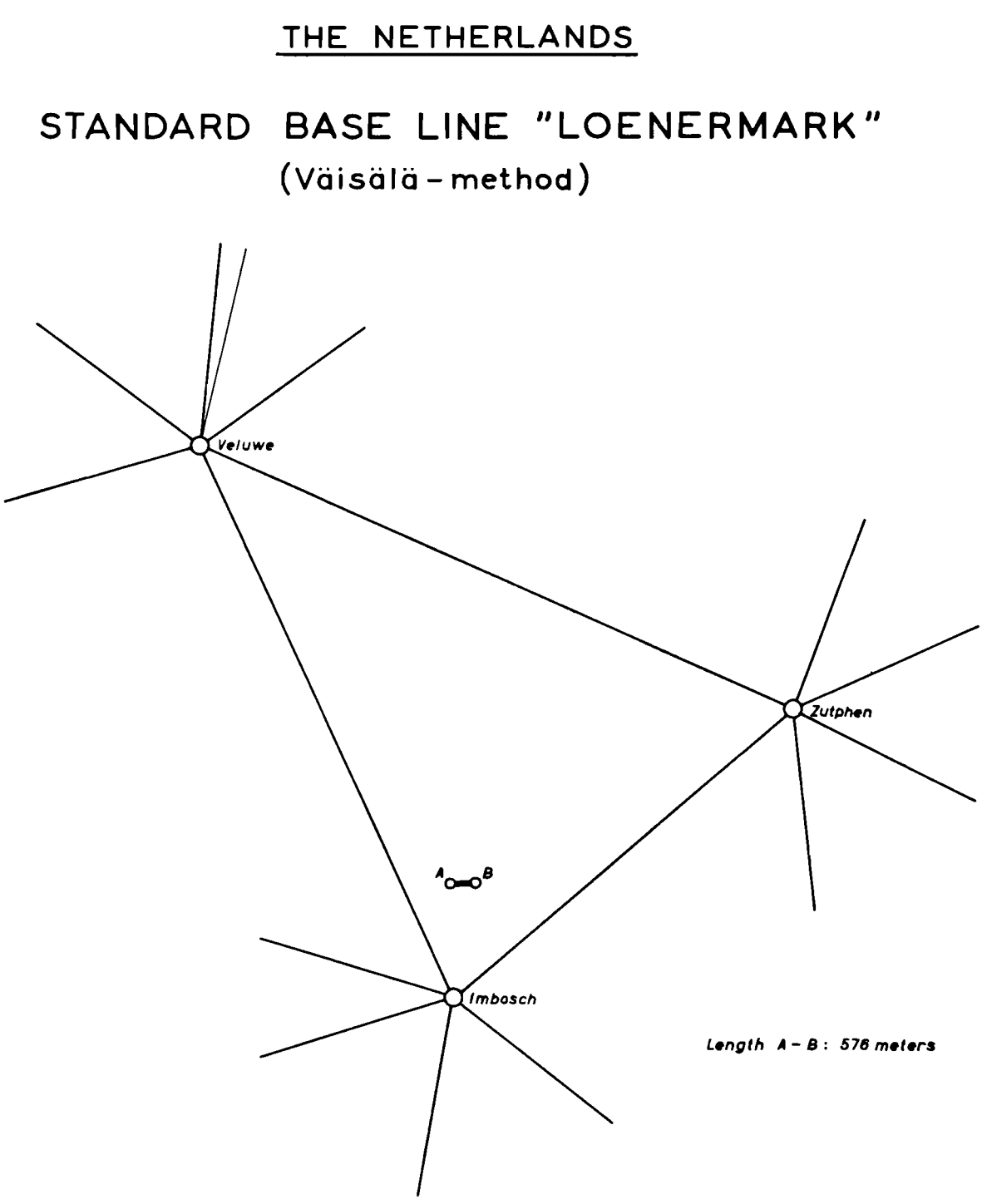

THE NETHERLANDS
STANDARD BASE LINE "LOENERMARK"
(Väisälä - method)
Veluwe
Zutphen
A
B
Imbosch
Length A - B : 576 meters

Fig. 1.2

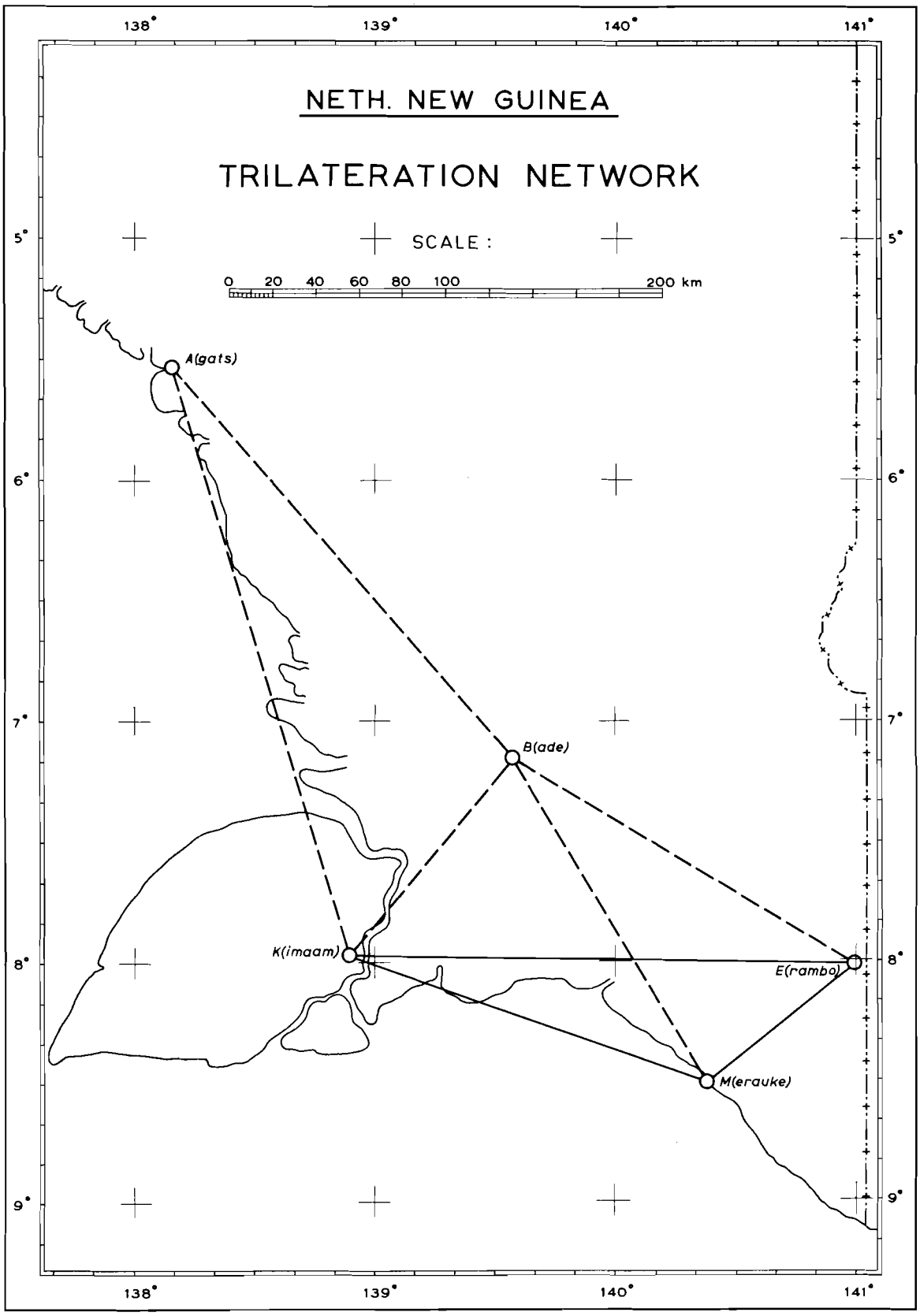

NETH. NEW GUINEA
TRILATERATION NETWORK
SCALE :
0 20 40 60 80 100 200 km
138°
139°
140°
141°
5°
6°
7°
8°
9°
A(gats)
B(ade)
K(imaam)
E(rambo)
M(erauke)

Fig. 1.3.2

2 PRECISE LEVELLING

THE NETHERLANDS, JAN. 1, 1954 – DEC. 31, 1956

2.1 *General information*

Measuring of the Third Precise Levelling was continued. During the report period lines to 1097 km were completed. Before 1954 a length of 1220 km was levelled; in the near future 1500 km will be measured to complete the network by the end of 1958. The progress is shown in Figure 2.1.

2.2 *Instruments*

About 750 km lines were measured with Wild N III. These instruments (2) are used on the Wild XI tripod which is very useful under rough weather conditions.
Another 220 km lines were measured with Zeiss A.
In 1956 two Fennel-Plani instruments were put into use; 127 km were levelled with these instruments. The results are of the same accuracy as those with Zeiss and Wild levels.
In second-order levelling Zeiss-Opton Ni-2 was used with optical micrometer and wooden rods. The standard deviation U_R in about 275 km was 0.8 mm/km. A first-order party is now equipped with this instrument and invar rods. It is expected that the use of invar rods and the accurate methods of such a party will decrease the said standard deviation to normal first-order standard (about 0.6 mm/km).
Perhaps it will be necessary to replace the middle-wire by a wedgeshaped one.

2.3 *Methods*

In the general Report of the Tenth General Assembly at Rome it was pointed out that the method of reading both graduations of the rod has been abandoned in 1951. It is a remarkable fact that by reading only one graduation of the rod the standard deviation U_R will decrease:

method I reading one graduation $U_R = 0.54$ mm/km $\left(475 \text{ values of } \frac{\varrho^2}{R}\right)$

method II reading two graduations $U_R = 0.59$ mm/km $\left(752 \text{ values of } \frac{\varrho^2}{R}\right)$

The errors of closure of 12 circuits (method I) resulted in a standard deviation $U_F = 1.21$ mm/km. It is to be feared that a small value of U_R is an indication for incomplete elimination of systematical errors, such as instrument-sinking and rod-sinking. For this reason the original method of reading both graduations was re-introduced in June 1955.
Some lines were relevelled (with method II) in trying to get better circuit closure, but this did not result in a smaller value U_F. These relevellings offered an occasion to compute the accuracy

of levelling by comparing two *complete* levellings of the same line. The difference in time between both levellings was between $1^1/_2$ to 4 years, so that it was necessary to use only heights of stable benchmarks for this comparison. The standard deviation determined from 53 differences of these two levellings was 0.75 mm/km (mean length $R = 3.0$ km).
We suppose this value 0.75 mm/km gives a better evaluation of the accuracy than the computed U_F, since this U_F comes from only 12 circuit closures.

2.4 *Datum of the network*

The datum of the network is still the "Normaal Amsterdams Peil" (N.A.P.), determined by marks in sluices at Amsterdam.
These marks (about 370 years old) were going to disappear in the course of 1955. An underground benchmark to replace them was constructed in December 1953. In the beginning of 1955 levellings were executed to connect the new mark with the old ones.

2.5 *Junctions*

With the German networks 10 junctions were measured in this period:
with Nordrhein-Westfalen:

Maasniel-Elmpt	Aalten-Hemden
Nijmegen-Nütterden	Eibergen-Wennewick
Zevenaar-Elten	Enschede-Gronau

with Niedersachsen:

Oldenzaal-Frensdorferhaar	Sellingen-Hasseberg
Coevorden-Emlichheim	Nieuwe Schans-Bunder Neuland

Since the new network is not yet completed only preliminary results of these junctions are available.

2.6 *Adjustment*

The 12 circuits already completed were adjusted according to the method of least squares. It proved that the preliminary altitudes of the underground benchmarks were in good agreement with the known altitudes.
For this reason the measurings were adapted to these known altitudes, so that provisional new altitudes of benchmarks in the levelling-lines could be computed and published. Vertical movements of benchmarks to be calculated from these preliminary altitudes are only of very local interest as a consequence of the way of adjustment.


The Netherlands
Third precise levelling
1950
levelled until jan 1954.
levelled from jan 1954 - jan. 1957.
program for 1957 and 1958.
underground benchmarks.
0 10 20 30 40 km
Leeuwarden
Groningen
Winschoten
Assen
Den Helder
Heerenveen
Lemmer
Meppel
Coevorden
Alkmaar
Zwolle
Haarlem
Amsterdam
Deventer
Enschede
Lochem
Amersfoort
Utrecht
's-Gravenhage
Gouda
Arnhem
Aalten
Rotterdam
Nijmegen
's-Hertogenbosch
Breda
Tilburg
Middelburg
Roosendaal
Eindhoven
Venlo
Roermond
Maastricht

Fig. 2.1

3 GEODETIC ASTRONOMY

3.1 **Establishment geodetic-astronomic station Curaçao, West-Indies**

A geodetic-astronomic station was established at the Isle of Curaçao, West-Indies, as one of the Netherlands' contributions to the International Geophysical Year 1957–1958.
It consists of six buildings: two dwelling houses for the two observers and their families, three buildings for the astronomical instruments and one building for the time keeping and recording instruments.
The station is equiped with:

1 impersonal astrolabe "Danjon" for simultaneous latitude and longitude determinations from equal altitudes of stars.
1 transit instrument "Pistor and Martins" with recording micrometer for time determinations from meridian transits of stars.
1 400 cm-telescope with moon position camera "Markowitz" for photographing the moon and neighbouring stars.
3 quartz clocks "Airmec".
1 printing chronograph "Belin".
1 tape chronograph "Great Northern Telegraph Cg".
3 radio receivers.
2 marine chronometers.
2 electric computing machines.

At the moment of making this report the construction of the buildings and the adjustment of the instruments has made such progress that the station may be expected to start its observations right at the beginning of the International Geophysical Year, 1 July 1957.

3.2 **Geodetic astronomy, Hydrographic Office Royal Netherlands Navy, 1954-1957**

Astronomical observations of latitude and longitude have been carried out in Neth. New Guinea at K, E and M (see Figure 3.2).
Equipment Wild T2 and Wild radio and chronograph.
Time signals WWVH.
Method R. Roelofs (described in Zeitschrift für Vermessungswesen Heft 4, April 1957).
Internal accuracy standard deviation of about 1″.
Plumbline deflection adopted to be zero at M and K.
Relative plumbline deflection in E 1.7″ North and 12.6″ West.
No topographic and isostatic corrections were applied (entirely flat terrain).
Some more details are given in the reports presented by J. Th. Verstelle at the General Assembly in Toronto.

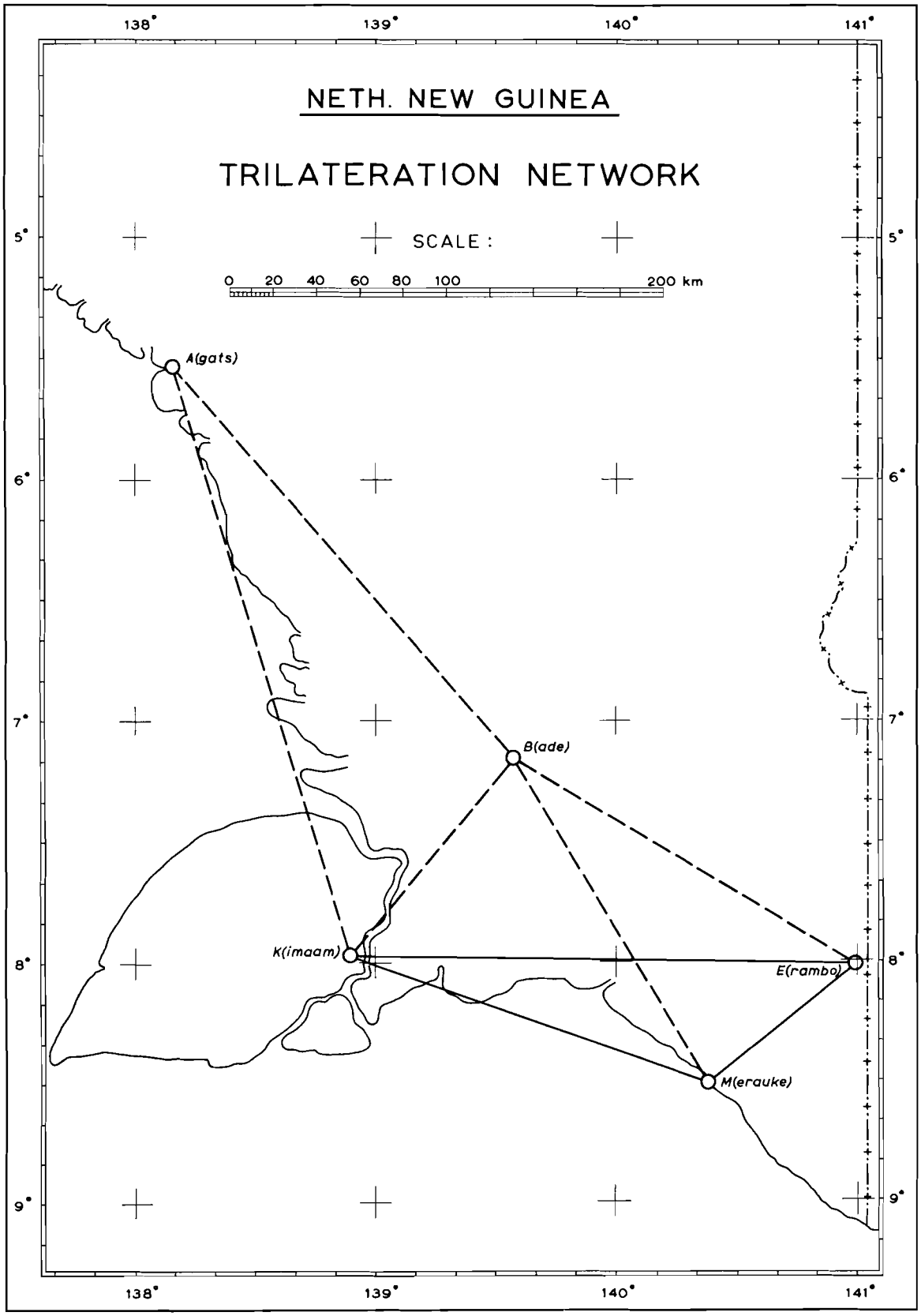

NETH. NEW GUINEA
TRILATERATION NETWORK
SCALE :
0 20 40 60 80 100 200 km
138°
139°
140°
141°
5°
6°
7°
8°
9°
A(gats)
B(ade)
K(imaam)
E(rambo)
M(erauke)

Fig. 3.2

4 GRAVIMETRIC OBSERVATIONS

AND INTERNATIONAL CONNECTIONS, 1954–1957

4.1 *General information*

Under the auspices of the Netherlands Geodetic Commission and in co-operation with the Royal Netherlands Navy about 180 gravity-observations have been carried out at the North Sea since 1954, partly with a remote-control gravimeter on board of Hr Ms frigate "Vos" in those parts where the depth was less than 90 meters, partly with the Vening Meinesz pendulum-apparatus on board of Hr Ms submarine "Zeeleeuw", where the depth was greater, up to a geographical latitude of about 61° North (see Figure 4.1). All those observations were carried out by Dr. B. J. COLLETTE and will be published in 1957.

A calibration base-line was established between De Bilt, the national reference station, and Eindhoven covering a range of 86 mgal. This base-line was measured with three gravimeters, which had been calibrated before on the German base-line Harzburg-Torfhaus. At the same time an international connection between Bad Harzburg and De Bilt was measured. The value $g = 981.267$ of De Bilt seems to be about one or two milligals too low. A definitive value of De Bilt will be published later on, as some more international connections will be measured in the future.

In May 1957 the German Geodetic Commission, in co-operation with the „Amt für Bodenforschung" in Hannover measured the international connection Bentheim (Germany) – De Bilt – Eindhoven – Uccle (Belgium) – Aachen (Germany). The results are not yet known.

4.2 *Instruments*

The gravimeter with remote-control apparatus, employed in the North Sea was of the North-American type while the pendulum observations were done with the Vening Meinesz apparatus. The international connection between Bad Harzburg and De Bilt as well as the establishment of the base-line De Bilt-Eindhoven were measured with two North-American gravimeters and one Askania-gravimeter Gs9.

The North-American gravimeters and also the remote-control apparatus were generously placed at the disposal of the Netherlands Geodetic Commission by the Bataafsche Petroleum Maatschappij.

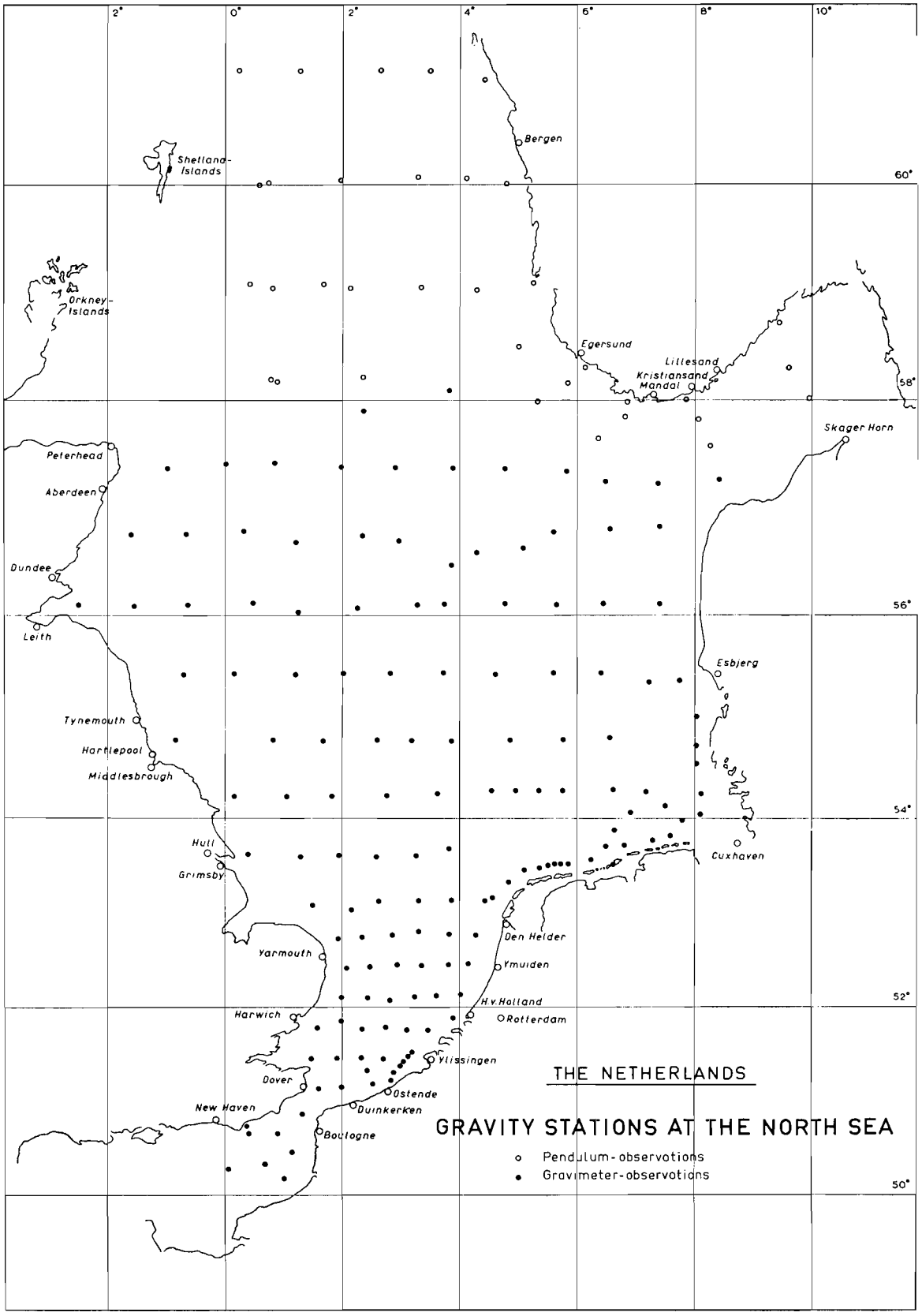

2°
0°
2°
4°
6°
8°
10°
60°
58°
56°
54°
52°
50°
Shetland-Islands
Orkney-Islands
Bergen
Egersund
Lillesand
Kristiansand
Mandal
Skager Horn
Peterhead
Aberdeen
Dundee
Leith
Tynemouth
Hartlepool
Middlesbrough
Esbjerg
Hull
Grimsby
Cuxhaven
Yarmouth
Den Helder
Ymuiden
H.v.Holland
Rotterdam
Harwich
Ylissingen
Dover
Ostende
New Haven
Duinkerken
Boulogne
THE NETHERLANDS
GRAVITY STATIONS AT THE NORTH SEA
Pendulum-observotions
Gravimeter-observotions

Fig. 4.1

5 DETERMINATION OF THE GEOID

5.1 *General information*

Neither an astronomic nor a gravimetric determination of the geoid has been carried out in The Netherlands. In 1954 only provisional values of ξ and η of three primary triangulation points were gravimetrically computed. Definitive computations of ξ, η and N could not be done because of two empty areas near The Netherlands, namely the North Sea and the Eifel, a mountainous region in Germany, bordering on The Netherlands. As soon as the anomalies at the North Sea and in the Eifel are known the computation of ξ, η and N of a series of primary triangulation points will start.

5.2 *Publications*

Gedenkboek F. A. VENING MEINESZ. Verhandelingen van het Koninklijk Geologisch Mijnbouwkundig Genootschap, Geologische Serie Deel XVIII, 's-Gravenhage, mei 1957.

F. A. VENING MEINESZ, The Geophysical History of a Geosyncline, I and II. Kon. Nederl. Akademie van Wetenschappen, Amsterdam. Proceedings, Series B, 60 Nr. 2, 1957.