



**UNITED NATIONS  
REGIONAL  
CARTOGRAPHIC CONFERENCE  
FOR ASIA AND THE FAR EAST**

---

**15-25 February 1955, Mussoorie, India**

**Vol. 2 - Proceedings of the Conference  
and Technical Papers**

**United Nations  
New York**



**UNITED NATIONS  
REGIONAL  
CARTOGRAPHIC CONFERENCE  
FOR ASIA AND THE FAR EAST**

---

**15-25 February 1955, Mussoorie, India**

**Vol. 2 - Proceedings of the Conference  
and Technical Papers**

**United Nations  
Department of Economic and Social Affairs  
New York, 1957**

E/CONF.18/7

12 September 1956

UNITED NATIONS PUBLICATION

Sales No. : 1956. I 23

Price : \$U.S. 1.50 ; 11/-stg. ; Sw. fr. 6.50  
(or equivalent in other currencies)

## FOREWORD

The official records of the first United Nations Regional Cartographic Conference for Asia and the Far East, held at Mussoorie, India, from 15 to 25 February 1955, are contained in two volumes : Volume 1, *Report of the Conference*,<sup>1</sup> and the present publication, Volume 2, *Proceedings of the Conference and Technical Papers*.

Part I of the second volume contains the summary records of the seven plenary meetings, at which official business and general questions were discussed, and draft resolutions prepared by the four technical committees were considered and approved. Part II contains the text of the studies, reports and communications submitted to the Conference by governments, specialized agencies and the Secretariat of the United Nations.

These technical papers are presented in the order in which they were provisionally issued at the Conference. They have been edited, consolidated or summarized in accordance with United Nations practice and requirements. Official publications attached to these papers are not reproduced in this volume as they are available elsewhere. The agenda, the list of participants and the resolutions of the Conference, all of which are frequently referred to in this volume, can be found in Volume 1.

As an aid to the reader, a Check List of Documents dealing with Technical Questions is provided; it follows the table of contents and lists by symbol number, the documents pertaining to each agenda item.

The annex to Volume 2 contains the rules of procedure and the text of resolution 600 (XXI) of the Economic and Social Council, which was adopted after consideration of the report of the Conference. This resolution provides, among other things, for the convening in 1958 of a second United Nations Cartographic Conference for Asia and the Far East.

---

<sup>1</sup> *United Nations Regional Cartographic Conference for Asia and the Far East : Volume 1, Report of the Conference*, E/CONF.18/6 (sales number : 1955.I.29).



## TABLE OF CONTENTS

### Part I. Proceedings of the Conference

	<i>Page</i>
Summary record of first plenary meeting . . . . .	3
Summary record of second plenary meeting . . . . .	6
Summary record of third plenary meeting . . . . .	8
Summary record of fourth plenary meeting . . . . .	12
Summary record of fifth plenary meeting . . . . .	15
Summary record of sixth plenary meeting . . . . .	16
Summary record of seventh plenary meeting . . . . .	20

### Part II. Technical documents presented to the Conference

International map of the world on the millionth scale: Means of bringing the task to completion (E/2376) . . . . .	25
International map of the world on the millionth scale: Table listing information received in 1953-1954 on sheets published or in preparation (E/CONF.18/A/L.1) . . . . .	36
Specifications for the international map of the world: Replies from national cartographic agencies (E/CONF.18/A/L.2) . . . . .	39
Standard method of writing geographical names on maps: Replies from governments (E/CONF.18/A/L.3) . . . . .	42
Assistance provided by the United Nations Technical Assistance Administration (E/CONF.18/A/L.4) . . . . .	48
Measurement of standard base lines with the Väisälä comparator (E/CONF.18/A/L.5), by T. J. Kukkamäki . . . . .	51
Recent developments in geodetic surveying and suggestions for other mapping questions (E/CONF.18/A/L.6/Rev.1), submitted by the delegation of the Federal Republic of Germany . . . . .	53
New ideas to expedite first-order triangulations, by E. Gigas . . . . .	53
Development of a method of measuring distances by modulation of high-frequency light waves, by E. Gigas . . . . .	56
Measurement of standard base lines, by E. Gigas . . . . .	61
Problem of the necessity to repeat base-line measurements in the European triangulation net, by E. Gigas . . . . .	62
How to organize a magnetic land survey, illustrated by the example of India, by R. Bock . . . . .	68
Suggestions relating to photogrammetric surveying of average accuracy and mapping on scales of 1:50,000 and 1:100,000, by R. Foerstner . . . . .	70
Establishing a land register (cadastre), by F. Kurandt . . . . .	73
Research institute or committee and common international research, by E. Gigas . . . . .	77
Communication received from the delegation of the Netherlands (E/CONF.18/A/L.7 and Add.1), by W. Schermerhorn . . . . .	78
Physical background surveys for a study of natural resources for agriculture (E/CONF.18/A/L.8), by F. George . . . . .	85
Communication received from the International Civil Aviation Organization (E/CONF.18/A/L.9) . . . . .	90
Communication received from the Universal Postal Union (E/CONF.18/A/L.10) . . . . .	91
Communication received from the delegation of India (E/CONF.18/A/L.11) . . . . .	92
Communication received from the International Telecommunication Union (E/CONF.18/A/L.12) . . . . .	99
Present status of cartography and related surveys in Japan (E/CONF.18/A/L.13), by N. Miyabe . . . . .	100
Instruments and methods used to prepare medium-scale maps of average precision in minimum time (E/CONF.18/A/L.14), by the Institut géographique national, Paris, France . . . . .	103

	<i>Page</i>
Recent progress in cartography and interesting technical developments in the United States (E/CONF.18/A/L.15), submitted by the delegation of the United States . . . . .	106
Means of obtaining regular small-scale photographic coverage (E/CONF.18/A/L.16), by the Institut géographique national, Paris, France . . . . .	113
Desirability of measuring a standard base line in India (E/CONF.18/A/L.17), by B. L. Gulatee. . . . .	115
Use of the international map of the world series in China (E/CONF.18/A/L.18), by Tang-yueh Sun . . . . .	116
Progress of cartographic work in China (E/CONF.18/A/L.19), by Tsao-Mo . . . . .	118
The figure of the earth from measurements in China (E/CONF.18/A/L.19), by Tsao-Mo . . . . .	120
Specifications governing the publication of the international map of the world on the millionth scale (E/CONF.18/A/L.20) . . . . .	122
International map of the world on the millionth scale : Map sheet index for Japan (E/CONF.18/A/L.21). . . . .	123
Facilities for studying new developments (E/CONF.18/A/L.22), submitted by the delegation of Burma . . . . .	124
Recent progress in Burma (E/CONF.18/A/L.23), submitted by the delegation of Burma . . . . .	125
Establishment of an inter-governmental cartographic organization (E/CONF.18/A/L.24), submitted by the delegation of Burma . . . . .	127
Central research organization (E/CONF.18/A/L.25), submitted by the delegation of Burma . . . . .	129

#### *ANNEX*

Rules of procedure . . . . .	130
International co-operation on cartography (resolution 600 (XXI)) . . . . .	133

## LIST OF ILLUSTRATIONS

	<i>Page</i>
International map of the world on the millionth scale : Index map showing status of publication in 1952 . . . . .	(Inserted between pages 38 and 39.)
<i>Figure</i>	
1. Diagram showing the principle of the electric eye . . . . .	54
2. View of the electric eye, mounted on an Askania theodolite I.O. . . . .	55
3. Diagram showing Kerr cell and optical arrangements . . . . .	56
4. Apparatus in figure 3 with a photoelectric tube device . . . . .	56
5. Characteristic curve of the Kerr cell . . . . .	57
6. Characteristic curve of the photoelectric tube . . . . .	57
7. Examples of phase difference . . . . .	58
8. Photograph of EM <sub>c</sub> apparatus . . . . .	59
9. Diagram of EM <sub>c</sub> apparatus . . . . .	59
10. Modulation of high-frequency light waves . . . . .	60
11. Phase meter . . . . .	60
12. Diagram of operation of Väisälä interference comparator . . . . .	63
13. Mirror mounted on supports . . . . .	64
14. Transfer of interference distance to measuring tape : diagram showing glass cylinder method . . . . .	64
15. Transfer of interference distance to measuring tape : diagram showing theodolite telescope method . . . . .	65
16. View of the one-metre base line and inserted quartz with plane-parallel terminal faces . . . . .	66
17. Optical arrangement for observing and photographing Lehmann's bands . . . . .	67
18. Lehmann's bands and the spectral lines (mercury and cadmium) . . . . .	67
19. Optical arrangement for the observation and measurement of Haidinger's rings . . . . .	68
20. Suggested location of observatories in India . . . . .	69
21. Index to the maps of the Carte internationale du monde . . . . .	92
22. Altitude scale . . . . .	94
International map of the world on the millionth scale : Map sheet index for Japan . . . . .	123

## LIST OF TABLES

1. Sheets published or in preparation . . . . .	36
2. Technical assistance fellowships and scholarships awarded from 1949 to 1954 . . . . .	50
3. Results of experiments with Wild and Zeiss cameras . . . . .	80
4. Gravity measurement at five stations in Japan . . . . .	101
5. Observation equations, from seven stations . . . . .	120
6. Normal equations . . . . .	121

# CHECK LIST OF DOCUMENTS<sup>1</sup> DEALING WITH TECHNICAL QUESTIONS

<i>Agenda item</i>	<i>Documents</i>
Item 5—Brief statements on recent progress and interesting technical developments in the respective countries	E/CONF.18/A/L.6 Rev.1; E/CONF.18/A/L.9; E/CONF.18/A/L.13; E/CONF.18/A/L.15; E/CONF.18/A/L.19; E/CONF.18/A/L.23; E/CONF.18/SR.3 and 7
Sub-item 6 (a) (i)—The application of airborne electronic devices for the connexion with India of outlying islands such as the Andamans and Nicobars	E/CONF.18/L.11; E/CONF.18/SR.7
Sub-item 6 (a) (ii)—The desirability of measuring one or more standard base lines in India and other Far Eastern countries with the Väisälä comparator developed at the Finnish Geodetic Institute	E/CONF.18/A/L.5; E/CONF.18/A/L.6 Rev.1; E/CONF.18/A/L.11; E/CONF.18/A/L.17; E/CONF.18/SR.7
Sub-item 6 (a) (iii)—Magnetic and gravity observations in the Bay of Bengal and the Arabian Sea	E/CONF.18/A/L.11; E/CONF.18/SR.7
Sub-item 6 (a) (iv)—The maintenance of national magnetic standard instruments and their comparison with European standards	E/CONF.18/A/L.6 Rev.1; E/CONF.18/A/L.11; E/CONF.18/SR.7
Sub-item 6 (a) (v)—First-order triangulation and levelling connexions between neighbouring countries (e.g., Iran, Iraq, Syria and Turkey)	E/CONF.18/SR.7
Sub-item 6 (b) (i)—Means of obtaining a regular small-scale photographic coverage in the sectors of a region where such coverage does not yet exist or where it appears to be insufficient	E/CONF.18/A/L.7; E/CONF.18/A/L.16; E/CONF.18/SR.7
Sub-item 6 (b) (ii)—The most appropriate instruments and methods to ensure the rapid execution of cartographic surveys of average precision and at a scale of the order of 1/50,000 or 1/100,000 by the use of aerial photographs in countries which are not yet provided with regular maps	E/CONF.18/A/L.6 Rev.1; E/CONF.18/A/L.14; E/CONF.18/SR.7
Sub-item 6 (b) (iii)—Improvement and standardization of cadastral survey methods	E/CONF.18/A/L.6 Rev.1; E/CONF.18/A/L.7; E/CONF.18/A/L.11; E/CONF.18/SR.7
Sub-item 6 (b) (iv)—Adoption of a standard method of writing geographical names on maps	E/CONF.18/A/L.3; E/CONF.18/A/L.9; E/CONF.18/A/L.10; E/CONF.18/A/L.12; E/CONF.18/SR.4 and 7
Sub-item 6 (c)—Topical maps	E/CONF.18/SR.7
Sub-item 6 (d)—Surveys which form the physical background for a study of natural resources	E/CONF.18/A/L.7; E/CONF.18/A/L.8 and Corr.1; E/CONF.18/SR.7
Sub-item 6 (e)—Hydrography	E/CONF.18/SR.7
Sub-item 6 (f)—Aeronautical charts	E/CONF.18/SR.6 and 7
Sub-item 6 (g)—International Map of the World on the Millionth Scale	E/CONF.18/A/L.1; E/CONF.18/A/L.18; E/CONF.18/A/L.21; E/2376 and Add.1
Sub-item 6 (g) (i)—Standardized specifications for the CIM series	E/CONF.18/A/L.2; E/CONF.18/A/L.9; E/CONF.18/A/L.11; E/CONF.18/A/L.20; E/CONF.18/SR.6 and 7
Sub-item 6 (g) (ii)—Interrelation of ICAO 1:1,000,000 series and CIM series	E/CONF.18/A/L.9; E/CONF.18/SR.6 and 7

<sup>1</sup> Including only documents reproduced in this volume, arranged in order of agenda items.

a-item 6 (g) (iii)—Limits of mapping responsibility for the <i>Carte internationale du monde au millionième</i> series	E/CONF.18/A/L.9; E/CONF.18/SR.6 and 7
a-item 7 (i)—Procedure for obtaining from adjacent countries information and mapping material in cases where the international mapping responsibility of one country extends over the territory of another country	E/CONF.18/A/L.11; E/CONF.18/SR.3, 4 and 7
a-item 7 (ii)—The establishment of an inter-governmental cartographic organization to work out uniform international cartographic standards and to give the necessary aid to less developed countries, as done by other inter-governmental organizations, so that the survey of the world may be expedited	E/CONF.18/A/L.7; E/CONF.18/A/L.9; E/CONF.18/A/L.24; E/CONF.18/SR.3, 4 and 7
a-item 7 (iii)—Questions relating to a central research organization or office to which problems can be referred and from which up-to-date information about various instruments may be obtained	E/CONF.18/A/L.6/Rev.1; E/CONF.18/A/L.7; E/CONF.18/A/L.25; E/CONF.18/SR.3, 4 and 7
b-item 8 (i)—A study of (a) the difficulties encountered by countries which have not been able to prepare adequate maps of their territories or to carry out adequate gravimetric and magnetic measurements and (b) the possibilities of the provision of technical assistance in this connexion	E/CONF.18/A/L.4; E/CONF.18/SR.3, 4 and 7
b-item 8 (ii)—Facilities for the less developed countries to study new developments in the neighbouring developed countries whenever opportunity arises	E/CONF.18/A/L.7; E/CONF.18/A/L.22; E/CONF.18/SR.3, 4 and 7
b-item 8 (iii)—Technical assistance activities in the field of cartography	E/CONF.18/A/L.7; E/CONF.18/SR.3, 4 and 7
Item 9—Adoption of the Report of the Conference	E/CONF.18/SR.7

## EXPLANATION OF SYMBOLS AND ABBREVIATIONS

The following symbols have been used throughout the report :

Three dots (...) in a table indicate that data are not available or are not separately reported

A dash (—) in a table indicates that the amount is nil or negligible

A full stop (.) is used to indicate decimals

A comma (,) is used to distinguish thousands and millions

A slash (/) indicates a crop year or fiscal year, e.g., 1953/54

References to "billions" indicate thousand millions. References to dollars are to United States dollars; to pounds, to pounds sterling.

Symbols of United Nations documents are composed of capital letters combined with figures (e.g., E/CONF.18/L.1). Mention of such a symbol indicates a reference to a United Nations document.

The abbreviation IMW has been used for "International Map of the World on the Millionth Scale"; the corresponding French abbreviation is CIM, "Carte internationale du monde au millionième". WAC stands for the World Aeronautical Chart (ICAO). Abbreviations for international organizations or specialized agencies include :

EOPER	European Organization for Experimental Photogrammetric Research
FAO	Food and Agriculture Organization of the United Nations
ICAO	International Civil Aviation Organization
IGU	International Geographical Union
IHB	International Hydrographic Bureau
ITC	International Training Centre for Aerial Survey (Delft, Netherlands)
ITU	International Telecommunication Union
IUGG	International Union of Geodesy and Geophysics
UPU	Universal Postal Union

**Part I**

**PROCEEDINGS OF THE CONFERENCE**

# SUMMARY RECORD OF FIRST PLENARY MEETING<sup>1</sup>

Held at Savoy Hotel, Mussoorie, India, on Tuesday, 15 February 1955, at 3 p.m.

## CONTENTS

Statement by the Temporary Chairman .....	3
Address by the Honourable Dr. Sampurnanand, Chief Minister of Uttar Pradesh .....	4
Vote of thanks to the Government of India .....	5
Adoption of the rules of procedure .....	5
Election of officers .....	5
Adoption of the agenda and establishment of technical committees .....	5

*Temporary Chairman:* Dr. Palamadai S. LOKANATHAN, Executive Secretary of the United Nations Economic Commission for Asia and the Far East.

### *Present:*

The representatives<sup>2</sup> of the following countries: Afghanistan, Belgium, Burma, Canada, China, Finland, France, Federal Republic of Germany, India, Indonesia, Israel, Japan, Netherlands, Philippines, Portugal, Thailand, Turkey and the United States of America.

Observers from the following organizations: Food and Agriculture Organization, International Civil Aviation Organization, International Hydrographic Bureau, International Organization for Standardization and International Union of Geodesy and Geophysics.

### Statement by the Temporary Chairman

The EXECUTIVE SECRETARY of the United Nations Economic Commission for Asia and the Far East, representing the Secretary-General of the United Nations, thanked the Government of India for its invitation to hold the Conference in India and for the excellent arrangements which had been made.

He recalled that, in promoting higher levels of living as well as the economic and social development stipulated in Article 55 of the United Nations Charter, the Economic and Social Council of the United Nations attached great importance to the provision by governments of adequate cartographic information. The Council had passed several resolutions dealing with

this matter,<sup>3</sup> and as a result of its interest this regional conference had been called.

It was significant that the first conference should concern Asia and the Far East. The continent of Asia had a wide range of topographic features and was inadequately surveyed and relatively unexplored. Countries of the region were keenly interested in raising the levels of living of their people, and there was urgent need for more food, more houses, more mineral production and better communications. The means of producing these essentials were various, but in every case they could be obtained more economically and more quickly with the help of adequate and reliable maps. Dr. Lokanathan recalled that, when coal and iron ore studies were first undertaken by the secretariat of the Economic Commission for Asia and the Far East, it had been obvious that an accurate assessment of any mineral resource could not be made without adequate geological knowledge, and, in turn, that systematic geological surveying could be done quickly only after systematic topographical mapping.

In addition to studying various questions relating to international co-operation in cartography, the Economic and Social Council had recommended measures to assist governments in developing their mapping facilities. Through technical assistance the United Nations and its specialized agencies had carried out projects in various branches of cartography in co-operation with many countries, located mostly in this region.

The Economic Commission for Asia and the Far East naturally took a particular interest in this Conference. Its secretariat had helped to produce maps and to set cartographic standards, particularly in the field of mineral resources development and similar fields. Together with the International Geological Congress and the United Nations Cartographic Office, the Economic Commission for Asia and the Far East had just convened a working party of senior geologists, who had agreed upon the main phases of preparation and publication of a regional geological map for Asia and the Far East. Furthermore, a meeting of mining experts had requested the secretariat to compile a mineral distribution map for Asia and the Far East, to be followed at a later date by a map showing the metallogenetic epochs and provinces of the region.

Surveying and mapping of areas were primarily the responsibility of the governments of the countries

<sup>1</sup> Issued as E/CONF.18/SR.1.

<sup>2</sup> For list of representatives and United Nations staff, who attended all plenary meetings, see *United Nations Regional Cartographic Conference for Asia and the Far East*, vol. 1, *Report of the Conference* (sales number: 1955.I.29), pages 2 to 4. Volume 1 will be referred to as *Report of the Conference* throughout the present volume.

<sup>3</sup> For a summary of the background of the Conference, see *Report of the Conference*, page 1.



concerned; nevertheless, the instances mentioned clearly showed that some problems were of international interest, and that close co-operation between nations was essential.

The wide range covered by the items proposed by governments and specialized agencies of the United Nations for the agenda of the Conference, as well as the attendance of outstanding technical experts, demonstrated the importance which governments attached to it. Dr. Lokanathan expressed confidence that the Conference would have significant effects in improved cartographic work in the countries of the region, as well as on development of their important economic and social projects.

The Temporary Chairman then expressed his gratitude to the Honourable Dr. Sampurnanand, Chief Minister of Uttar Pradesh, for having come to inaugurate the Conference.

**Address by the Honourable Dr. Sampurnanand,  
Chief Minister of Uttar Pradesh**

The Honourable DR. SAMPURNANAND thanked the sponsors of the Conference and the Government of India for deciding to hold this meeting in Mussoorie and extended a warm welcome to the participants on his own behalf and on behalf of the Government of Uttar Pradesh.

He recognized that cartography was a modern science but, like most sciences, it had a history whose beginnings no man knew. One day one of our savage forefathers etched on the solid rock of his cave habitation a picture of the neighbouring terrain, showing forests and lakes or rivers where food could be had in abundance. To make his meaning perfectly clear he no doubt drew representations of fish and shikar animals in appropriate places. He might have done so merely to satisfy a creative urge or perhaps he wanted to leave a record for his son. Even if his work lacked a sense of proportion, he had nevertheless been not only the first mural painter but the first cartographer. Judged by modern standards, early map drawings looked funny, but the gaps in objective knowledge had been wide. Not all the old maps were based on fairy tales, however; some were the result of painstaking effort. That could certainly be said of some of the maps that were drawn about five hundred years ago, beginning, for example, with Juan de la Cosa's map of the New World, prepared in 1500. Accuracy had been growing apace in the years since then, along with the development of more scientific techniques. Today, man did not stop at the earth but mapped Mars and the moon without having set foot on those planets. If space travel were to become a reality, future conferences would no doubt be discussing problems arising from the extra-terrestrial expansion of the cartographer's field of activities.

Quoting from the preamble to Economic and Social Council resolution 131 (VI), "accurate maps are a prerequisite to the proper development of the world resources which in many cases lie in relatively unexplored regions", he stated that it was also an indisputable fact that "the co-ordination of the cartographic services of the United Nations and specialized agencies,

as well as those of the Member nations, will result in significant economies in cost, time and personnel, and will contribute to the improvement of cartographic techniques and standards".<sup>4</sup> States which were Members of the United Nations had not all had equal opportunities of devoting their attention to cartography. Fairly accurate maps showing political subdivisions and the positions of the principal seas, rivers and mountains were still luxuries in certain parts of the civilized world. Conferences of this kind not only serve as clearing houses of information about the work being done but through their discussions helped to disseminate knowledge, lay down criteria and evolve techniques which were likely to be of permanent use to cartographers all the world over. India had been trying to do some useful work in the field; some of the subjects which had been put on the agenda at its suggestion gave an indication of that country's interest, academic and practical, in the subject.

Such conferences, furthermore, acted as cultural links between nations. The persons who attended them were not only scientists but ambassadors of peace from their countries. The contacts established in this way, the insight gained about one another's earnestness to increase the bounds of knowledge and service beyond the confines of race and nationality, should act as powerful factors in bringing humanity closer together.

This was the first inter-governmental conference on cartography for this region. Cartography today was not confined merely to the drawing of maps, but was the science of preparing all types of maps and charts, including every operation from original surveys to final printing of copies. Maps and charts nowadays included (1) topographic maps; (2) geologic maps, soil maps, vegetation maps, cadastral maps, hydrologic maps, hydrographic charts and aeronautical charts, all of which were prepared upon a topographic map base; and (3) office-compiled maps showing the location, extent and character of physical, economic and social phenomena. Quite obviously a number of ancillary subjects came within the purview of a body like this because the frontiers of cartography abutted on those of a number of sciences dealing with varied aspects of the earth, not only what lay on the surface but what was buried below and what grew above. The agenda of the Conference was long, and a layman like the speaker would not attempt to discuss it, but from it there were bound to emerge useful results.

To India, cartography and its practical application were matters of immediate concern. India was engaged at present in vast development projects, which were straining all its resources to the utmost, and it was of the greatest importance that its efforts should give the maximum result. His country fully endorsed the following observations in the report<sup>5</sup> of the committee of experts which met at Lake Success in 1949:

<sup>4</sup> *Resolutions adopted by the Economic and Social Council during its Sixth Session*, page 37.

<sup>5</sup> *Modern Cartography: Base Maps for World Needs* (United Nations publication, sales number: 1949.I.19), chapter V.

" Examples of failures of projects involving land and water use are legion. The irrigation dams that fill with precious soil needed for agricultural production are, in some nations, popular jokes. In reality they are not subjects for humour, even of the most wry sort. They are social and economic crimes, and they are caused almost invariably by lack of adequate knowledge of the terrain, the geology, the soils, the vegetation, and the hydrology of the area concerned. The famous incident of the water that never quite got to the newly built dam, hopefully constructed for irrigation and power purposes, is not fictitious. It happened. The geological structure of the area presumably to be flooded was so porous that the water simply sank into the ground.

" Nor is the damage from inadequate knowledge of physical facts confined to simple and, so to speak, isolated improvement projects. The woes to be anticipated from the really pathetic and practically criminal ignorance in such matters in the case of more complex proposals are even greater. Projects for regional development, embracing agriculture, industry, and commerce in many branches, should be scrutinized even more carefully, to the end that their original planning and designing be preceded by cartographic surveys which will provide the essential facts. "

These were what might be called the material aspects of life, but he felt that the committee was essentially right when it noted that cartography could be of great utility even in the solution of problems of social development and administration. <sup>6</sup>

In conclusion, he observed that the deliberations of this Conference were of great interest to the Indian Government and undoubtedly also to the other governments represented at the Conference. He wished the participants all success.

#### Vote of thanks to the Government of India

Mr. LACLAVERE (France) expressed his Government's thanks to the Government of India for having organized the regional cartographic conference at Mussoorie. He proposed a resolution thanking the Government for its hospitality.

Dr. MIYABE (Japan) supported the draft resolution.

*The resolution<sup>7</sup> was adopted unanimously.*

*The meeting was suspended at 3.40 p.m. and resumed at 4 p.m.*

#### Adoption of the rules of procedure [Item 1 of the agenda]

The TEMPORARY CHAIRMAN submitted to the Conference the draft rules of procedure.

*The rules of procedure<sup>8</sup> were adopted.*

<sup>6</sup> Ibid, page 16.

<sup>7</sup> For the text of the resolution see *Report of the Conference*, page 5.

<sup>8</sup> See pages 130 to 132.

#### Election of Officers [Item 2 of the agenda]

Mr. SUWANKATE (Thailand) nominated as President the Chairman of the Indian Delegation, Brigadier I. H. R. Wilson.

*Brigadier Wilson was elected President by acclamation and took the Chair.*

The CHAIRMAN thanked the Conference for the honour it had bestowed upon India and upon himself. In accordance with rule 6 of the rules of procedure, the vice-chairmen and a rapporteur were to be elected. As some delegations had not yet arrived, he proposed to postpone this item of business till the next meeting.

*It was so decided.*

#### Adoption of the agenda and establishment of technical committees [Item 3 of the agenda]

The CHAIRMAN submitted to the Conference the provisional agenda.<sup>9</sup> He mentioned that sub-item (6) (g) (i) had been withdrawn by the Indian delegation and consequently sub-items (g) (ii) and (g) (iii) were to be renumbered (g) (i) and (g) (ii). Furthermore, the item originally numbered 6 (g) (iii) had been proposed by Australia, which had no representation at the Conference. Consequently, the item would be eliminated unless it was sponsored by another delegation. Similarly, the alternative wording for item 7 (1) suggested by Syria now had no sponsor, and therefore the item in its original, more restricted, wording would stand.

He suggested the formation of four technical committees; their composition and the allocation of agenda items to them would be voted upon at the following plenary meeting, after representatives had had an opportunity for informal exchange of views on the subject. Tentatively, the following programme and allocation of items were suggested :

Committee I, questions of geodesy and hydrography  
Items allocated : 6 (a) (i), (ii), (iii), (iv) and (v); and 6 (e)

Committee II, topography and photogrammetry  
Items allocated : 6 (b) (i), (ii) and (iii)

Committee III, special mapping  
Items allocated : 6 (c) and 6 (d)

Committee IV, global mapping  
Items allocated : 6 (f) and 6 (g) (i)  
Items 5, 6 (b) (iv), 7, 8 and 9 would be examined at plenary meetings.

The committees were open to all countries represented at the Conference. No two committees would meet at the same time, thus delegations composed of only one representative could attend all meetings.

The meeting rose at 4.25 p.m.

<sup>9</sup> E/CONF.18/1.

## SUMMARY RECORD OF SECOND PLENARY MEETING<sup>1</sup>

Held at Savoy Hotel, Mussoorie, India, on Wednesday, 16 February 1955, at 10 a.m.

### CONTENTS

	Page
Election of officers ( <i>continued</i> ) .....	6
Organization of work .....	6
Adoption of the agenda and establishment of technical committees ( <i>continued</i> ) .....	6
Report on credentials .....	6

Chairman: Brigadier I. H. R. WILSON (India)

Election of officers (*continued*)

[Item 2 of the agenda]

The CHAIRMAN called for nominations for the posts of Vice-Presidents and Rapporteur.

Mr. GULATEE (India) proposed as First Vice-President Dr. Miyabe, head of the delegation of Japan.

*Dr. Miyabe was unanimously elected First Vice-President.*

Dr. SCHERMERHORN (Netherlands) proposed for the other post of Vice-President, Major-General Dura, head of the delegation of Turkey. General Dura was not present, but would certainly arrive soon.

*General Dura was unanimously elected Second Vice-President.*

Mr. LACLAVERE (France) proposed Mr. Suwankate, head of the delegation of Thailand, for the post of Rapporteur.

*Mr. Suwankate was unanimously elected Rapporteur.*

### Organization of work

After a discussion in which the representatives of Canada and the United States of America took part, it was proposed that the Conference would meet from 10 a.m. to 12.30 p.m. and from 2.30 p.m. to 5 p.m., subject to alteration if work required.

*It was so decided.*

Adoption of the agenda and establishment of technical committees (*continued*)

[Item 3 of the agenda]

The CHAIRMAN drew the attention of the Conference to the proposal he had made at the first plenary meeting as to the formation of committees and allocation of agenda items.

Dr. GIGAS (Federal Republic of Germany) drew attention to the fact that item 5 of the agenda covered

many questions. Were these to be discussed by the committees or in plenary meetings?

Dr. SCHERMERHORN (Netherlands) proposed that statements on recent progress and technical developments be made in the respective committees; whatever might remain under item 5 after this discussion might be examined in a plenary meeting later on.

*This proposal was adopted.*

The CHAIRMAN submitted to the Conference the list of committees and allocation of items he had suggested at the first plenary meeting. He pointed out that the delegation of India had decided to sponsor the item: "Interrelation of ICAO 1:1,000,000 series and CIM series", which had been originally proposed by the delegation of Australia. This item would be designated as 6 (g) (ii) and allocated to Committee IV.

*With this change, the agenda and the programme were unanimously adopted.*

The CHAIRMAN pointed out that the order of discussion of items in the plenary meetings would be items 6 (b) (iv), 7, 8, 9 and possibly 5, if part of it remained for discussion after examination in the several committees.

*The meeting was suspended at 10 45 a.m. and resumed at 11 15 a.m.*

### Report on credentials

[Item 4 of the agenda]

The CHAIRMAN reported that he and the other officers had examined the credentials of delegations and had found them to be in order, with the exception of the Indonesian delegation, whose credentials were due to reach Mussoorie soon, and should, he recommended, be provisionally accepted.

Dr. GOPAL (India) moved that the credentials of the representative of the "Kuomintang" not be accepted. The participation of China in the Conference was not being questioned; the problem was only to know who should represent that country. The point of view of the Indian Government on this subject was well known: it considered that the Central People's Government of the People's Republic of China commanded the confidence and the allegiance of the people and was in a position to fulfil the international obligations laid down in the Charter of the United Nations.

Lieutenant-Colonel SURJOSUMARNO (Indonesia) supported the proposal of the representative of India.

The CHAIRMAN put the motion of the representative of India to a vote.

*The motion was rejected by 6 votes to 2.*

<sup>1</sup> Issued as E/CONF.18/SR.2.

The CHAIRMAN explained that, since the motion India challenged the findings of the Credentials Committee, he had felt obliged to put it to a vote.

Dr. TCHEN (China) remarked that the Credentials Committee did not examine credentials from the Komintang as this word was unknown under the circumstances. The Chinese delegation had been accredited by the Government of China, which was Member of the United Nations and had been, in that capacity, invited by the Secretary-General to attend the Conference. He referred to rule 2 of the rules of procedure; the credentials had been duly issued by the competent authorities.

M. DEGROODT (Belgium) stated that, if he had properly understood the motion, he would have taken part in the vote and voted against it.

Mr. LACLAVERE (France) said that, in his opinion, the vote had been taken on an issue which was outside the competence of the Conference and should consequently not be mentioned in the summary record.

The CHAIRMAN stated that, since the motion of the Indian delegation referred to the findings of the Credentials Committee, and the conference had endorsed these findings, the matter should be mentioned in the summary record.

The meeting rose at 11.35 a.m.

on a scale of 1:200,000 in twenty-four sheets had been completed. Work was in progress on a 1:50,000 scale map (56 sheets) of which twenty-two sheets had been published, and on one of 1:20,000 scale (260 sheets) of which 118 sheets had been published. Photogrammetry was being used for the preparation of a 1:10,000 topographic map of which forty-one sheets were ready. Topical maps—geological, meteorological, historical and soil conservation maps—were also being published. As regards cadastral surveys, out of a total territory of 20,000 square kilometres, 10,000 kilometres were settled, of which 6,000 had already been the object of a cadastral survey at a scale of 1:2,500 or more, resulting in the preparation of 10,000 blocks.

Israel possessed two institutions for professional training, a higher studies institute in Haifa and a school which prepared surveyors by means of courses lasting two years.

Lieutenant-Commander MAULAWIN (Philippines) stated that geodetic and hydrographic work in his country was being carried out, particularly in connexion with harbours, and some levelling work was being done in connexion with irrigation and engineering projects. Magnetic surveys were also being made in order to correct the magnetic declination on maps: five primary stations had been established for that purpose and tables were being printed. As to cartographic publication work, it was mainly limited to reprinting old maps which had been brought up to date.

Dr. LABORINHO (Portugal) regretted that, contrary to its intention, his country had been unable at the very last moment to send an expert cartographer as its representative to the Conference. Not being a cartographer himself, he would not venture into any attempt to outline the scientific work which was being carried out in Portugal by distinguished specialists and organizations, which followed the latest developments in cartography.

A document prepared by Portuguese specialists was being sent to the Conference; unfortunately it would arrive too late.

His own presence at the Conference showed that Portugal was deeply interested in the work of the Conference, as in every other endeavour to promote international understanding. Contacts between nations in fields where co-operation was possible and desirable were bound to improve international relations and to break down barriers. This was Portugal's aim in every field of human activity.

Major ATES (Turkey) stated that, in his country, in respect of triangulation, observations and computations for the establishment of sixty-five chains of the first order, consisting of 870 points and forming twenty-six loops, had been completed in 1953. The general geodetic and astronomical adjustment had been finished in 1954. In this adjustment forty-one base lines and 105 loops had been introduced. More than half of the country had been covered by second-order triangulation.

In regard to levelling, twenty-three polygons forming loops of 12,000 kilometres had been established. Some precise levelling had been carried out by the end

of 1954 in addition to 2,300 levelling lines of the second order. Three connexions had been established between the Mediterranean, Aegean, Black and Marmara seas.

By the end of 1954, 105 Laplace stations had been established on the first-order triangulation points, and it was planned to open twenty or thirty more in the next two years along the chains running from the Greek to the Syrian borders; these would be used for determination of the geoidal section. Seven pendulum stations had been established at uniformly located points. Twenty-nine gravimetric stations were to be established at airports, where measurements were to be made by airborne Norgaard gravimeters.

The capacity of the magnetic observatory in Istanbul was insufficient for field measurements; therefore a complete set of equipment for a magnetic station had been purchased, to be established in the central part of the country. Field measurements were to begin the coming year.

Maps were being established by aerial photogrammetry only. The country already possessed thirteen Zeiss stereoplanigraphs, three Wild A7 and one Santoni plotting instruments and eight photographic aircraft. Although different methods of horizontal and vertical controls of aerial triangulation had been used, there was still room for improvement in order to achieve the desirable degree of precision.

The maps being prepared were mainly topographical maps for military purposes, maps for economic development and charts on a 1:1,000,000 scale for air navigation. Maps covering the whole area on scales of 1:200,000, 1:250,000, 1:500,000 and 1:800,000 had been published long ago; now efforts were concentrated upon establishment of the basic 1:25,000 map, half of which was already completed. In addition, maps at scales of 1:10,000, 1:5,000, 1:2,000 and 1:1,000 were being prepared when they were needed. The aeronautical charts he had already mentioned were being prepared in accordance with the specifications of the International Civil Aviation Organization.

Colonel MILLER (United States of America) mentioned a few technical developments in his country. The United States had embarked upon mass production of terrain models using the vacuum forming process on thermoplastic materials. This process was also being used by civilian firms for production of relief maps for general sale.

In the field of geodesy, the United States was sponsoring studies of solar eclipses and a programme of study of star occultation in the Pacific Ocean areas.

In the field of cartographic techniques, he felt that certain developments were of special interest. One of these was high-altitude photography, used in making maps at a scale of 1:60,000. Another—negative scribing on specially coated plastic materials—had led to a 75 per cent saving in the cost of manuscript preparation. Use of the KC-1 aerial mapping camera, with a six-inch f/6.3 planigon lens which had less than 20 micron radial distortion was another development. Use of grainless plates in map and chart reproduction eliminated the need for grainers and prolonged the life of the plates. Helicopters were now used extensively

field surveys, and machines were rented by private firms at rates which made these field surveys quite economical. The development of electronic computers made it possible to solve quickly complicated mathematical problems, such as large geodetic adjustment, extensive grid conversions and analytical solution of photogrammetric questions.

As to geological maps, considerable progress had been made. The same was true of soil maps; in the past 10 years, thirty-one soil surveys had been published, bringing the total to 1,647 surveys covering 12 million acres of detailed survey, while 14 million acres had been covered by reconnaissance survey.

Hydrographic surveys to provide nautical charts were continued in all oceans, especially in areas with which the United States had considerable trade. Significant progress had also been made in the field of aeronautical charting. Existing material was being improved. An important new development was the electronic navigation chart.

He should add that the United States had an extensive world-wide gravity programme, which included tying in with many national gravity base stations.

Rear-Admiral NICHOLS (International Hydrographic Bureau), referring to the statement of Dr. Labouche, pointed out that Portugal had successfully applied electronic instruments to hydrographic surveys and that a detailed description of these techniques had been given by the Portuguese officer in charge of the project.

The CHAIRMAN pointed out that no resolution was called for on this item of the agenda. The discussion, however, had been extremely useful in furthering international co-operation.

Mr. MILLER (Canada) thought that the Conference could record the fact that cartography was an indispensable tool of economic development and indicate by cartographic work needed to be continued and developed. Experience had shown that money invested in cartography was repaid many times over in the tangible benefits derived from this work.

The CHAIRMAN agreed, and suggested that, in the report of proceedings, a sentence might be included pointing out that the importance of cartography was universally recognized and that, unfortunately, some of the countries of the region were still below the desirable standards in this matter. He proposed that a small drafting group composed of Dr. Tchang (Executive Secretary for the Conference), Mr. Miller (Canada) and himself be appointed to establish a draft text on this item.

*It was so decided.*

#### Technical assistance [Item 8 of the agenda]

Mr. MILLER (Canada) pointed out that sub-items (i) and 8 (ii) were very similar and proposed to combine them for the purpose of discussion.

The CHAIRMAN supported this proposal and suggested the inclusion also of sub-item 8 (iii).

*It was so decided.*

Major ATES (Turkey) stated that some countries which had engaged in magnetic and gravimetric measurements need technical assistance but could not pay the expenses of foreign experts. He wondered whether such experts could not be supplied by the United Nations Educational, Scientific and Cultural Organization.

Mr. MILLER (Canada) had some personal experience of the problem and knew how difficult it was to find experts to work abroad for as long as one year. The very few top specialists who could advise foreign governments generally held key positions in their own countries and could not be spared. Being unfamiliar with United Nations procedures, Mr. Miller wondered whether better results could not be achieved by sending technicians for additional training abroad. Canada would gladly co-operate in all efforts made in this direction.

Dr. TCHANG (Executive Secretary for the Conference) explained that, under the United Nations Expanded Technical Assistance Programme, in which both the United Nations and its specialized agencies participated, countries could request the services of experts. Requests for experts in the general economic field were to be addressed to the United Nations while requests for experts in the field of competence of a specialized agency should be addressed to that agency. As to questions raised by Mr. Miller regarding the sending of technicians abroad, the Technical Assistance Administration had already granted some fellowships in the field of cartography. Examples could be found in the document prepared by the Technical Assistance Administration of the United Nations for the Conference.<sup>4</sup>

U MAUNG (Burma) pointed out that, as the report<sup>5</sup> of the Committee of Experts on Cartography indicated, one of the basic causes of an inadequate level of cartographic work was "lack of exchange of experience and of the interchange of information, not so much as between the more highly developed countries themselves, but rather as between these and the lesser developed countries". Thus, the less developed countries were left in a state of stagnation and had often to content themselves with obsolete, uneconomical methods. The provision of facilities for studying new developments in more developed countries would prove a powerful weapon to counteract lack of technical knowledge.

As the persons who would be sent to developed countries would have already received complete training, their stay abroad would not have to be extensive and would not involve considerable expense; they might witness new experiments and thus be prepared to apply new methods in their own countries. Such assistance would lead to adoption of more uniform international cartographic standards; through employment of identical methods in surveying boundary regions, it would facilitate the solution of boundary disputes and lead to better international understanding.

The meeting rose at 12.40 p.m.

<sup>4</sup> See part II of this report, page 50.

<sup>5</sup> *Modern Cartography: Base Maps for World Needs*, page 9.

# SUMMARY RECORD OF FOURTH PLENARY MEETING<sup>1</sup>

Held at Savoy Hotel, Mussoorie, India, on Saturday, 19 February 1955, at 2.30 p.m.

## CONTENTS

	Page
Technical assistance ( <i>continued</i> ) .....	12
Adoption of a standard method of writing geographical names on maps .....	13

Chairman: Brigadier I. H. R. WILSON (India)

### Technical assistance (*continued*) [Item 8 of the agenda]

The CHAIRMAN, summarizing the previous meeting's debate on the subject, observed that it was sometimes difficult to obtain highly qualified technical experts from abroad, and that an alternative method was to send students or fellows to other countries for specialization in questions of particular interest for their country of origin. Dr. Tchang had explained the procedures for requesting technical assistance from United Nations authorities. The Chairman felt that it would be sufficient to take note of these procedures and that no resolution was called for.

Dr. SCHERMERHORN (Netherlands) noted that it was sometimes difficult to obtain the services of experts through the United Nations. Consultative experts might act in a merely advisory capacity, in the preparation of plans and projects, in which case their missions were usually short and raised no particular difficulties. On the other hand, when they were entrusted with work such as the establishment of national organizations, their missions had to be much longer and did not always fit in with the budget possibilities of the United Nations technical assistance programme. For this reason, experts had sometimes been recalled in spite of the wishes of the governments concerned.

The programme of scholarships and fellowships was also deficient in certain respects: for instance, at the present time, requests for scholarships would be for 1956, and yet answers could not be expected before the end of 1955, so that the requesting governments, the students and the host institutes would remain in uncertainty for a whole year. This was also due to budget considerations. Dr. Schermerhorn's experience in this matter had convinced him that any study abroad should be preceded by a period of training in the home country. The most suitable course would be for a former fellow to become a lecturer in his own country and select the students he considered as most

eligible for a course of six to ten months abroad. In this way, scholars and fellows would not lose contact with their home country, while the chance of a scholarship abroad would provide an additional incentive during their studies at home. Training abroad could be followed by visits to research institutes, plants, and the like. Furthermore, it was essential to make sure that trips abroad were, in fact, profitable to students, by carefully selecting typical installations and facilities for their study and by requiring reports on visits and field trips. It was also both possible and useful for foreign students to participate in actual research after completion of their courses abroad.

With sufficient funds, the United Nations could provide all countries of the region with adequate cartographic personnel within ten to fifteen years. Unfortunately, the United Nations technical assistance programme had a very unstable budget, as some of the important contributing countries rarely accepted liabilities for periods of more than six months. Lack of co-ordination between bilateral assistance programmes and the multilateral assistance provided by the United Nations was to be deplored. Dr. Schermerhorn regretted that all assistance funds were not distributed through the United Nations, of which both contributing and benefiting countries were members, thus giving the latter the chance to express their needs. In too many cases, bilateral assistance had been—in effect although not in principle—practically forced upon the less developed countries. The western countries committed a great mistake if they believed they could tell less developed countries what was good for them. That was for the latter to decide. Technical assistance was a delicate question, upon which depended to a great extent all future co-operation between the western and the Asian worlds. Dr. Schermerhorn announced that there was a strong tendency in the Netherlands to increase considerably the contribution of that country to the United Nations technical assistance programme and expressed the hope that the programme's activities would be multiplied, and would include as well amounts now spent on bilateral programmes.

Major ATES (Turkey) qualified the statement he had made during the previous meeting. When he had spoken of the necessity of technical assistance for various countries in the field of magnetic and gravimetric observations, he had not been referring to Turkey in particular. His country had sufficient means and personnel for its own needs in this field. However, when he had suggested that a highly qualified United Nations expert might be sent to Turkey, it was

<sup>1</sup> Issued as E/CONF.18/SR.4.



h a view to accomplishing work consistent with similar activities in other countries and to facilitating international standardization.

Dr. SCHERMERHORN (Netherlands) noted that suggestion of the Turkish delegation tended towards maintenance of certain general scientific services at the United Nations. He thought this would be useful and regretted the recent trends towards reducing United Nations "office expenses", which would lead to the suppression of a number of highly efficient subordinate officers. He thought that all funds available could not be spent on field work, but that it was indispensable to set aside a certain amount for technical and scientific operations at the headquarters of the United Nations and of its specialized agencies. He had great doubts about the possibility of implementing the new policy, which requested all Member States to ensure full co-ordination of their own technical assistance programmes. This measure assumed that *dirigisme* existed in the lesser developed governmental organizations than in the so-called advanced countries. Finally, he urged all delegates to use their influence with their governments to obtain technical assistance in the field of cartography; merely formal proceedings would not be sufficient.

Mr. GEORGE (Food and Agriculture Organization of the United Nations) recalled that his organization had one of the most extensive technical assistance programmes of the United Nations. In many fields, the work of the Food and Agriculture Organization was related indirectly to cartography. For instance, assistance had been given in soil surveying in a number of Middle Eastern countries, irrigation had been promoted in many regions and a series of ecological studies had been undertaken. Mr. George's experience was that, in all fields, the training of national technicians was essential to ensure continuity of work. Co-operation with countries giving bilateral aid had been quite favourable and was constantly improving. One encouraging example had been the free co-operation of junior technicians offered by the Netherlands. Of course, the fact that the technical assistance budget was apt to vary greatly from year to year was a difficulty, as was the necessity of channelling and selecting requests through one central agency. It was to be feared that the procedure would be still more complex in later years. One remedy would be for countries considering a specific project requiring technical assistance to discuss it beforehand by correspondence or during visits between their representatives and officials of the specialized agencies concerned.

Rear-Admiral NICHOLS (International Hydrographic Bureau) observed that his organization had an excellent record of co-operation in technical assistance. He felt that this was mainly due to the frequent meetings and discussions of the chiefs of the various national cartographic services sponsored by the International Hydrographic Bureau and that this procedure could be equally useful to cartographers.

Mr. LACLAVÈRE (France) observed that, as Secretary-General of the International Union of Geodesy and Geophysics, he had frequently received

correspondence from countries desiring to develop their geophysical services and programmes. In particular, these countries wished to know to what institutions they could send their fellows and technicians for basic or advanced education in various fields of cartography and geophysics. Mr. LACLAVÈRE therefore suggested that the Cartographic Office of the United Nations should establish and publish a comprehensive list of such institutions, including a precise description of the subjects given, the duration of the courses and the cost of the training.

Dr. TCHANG (Executive Secretary for the Conference) said such a list could be compiled but could be published by the United Nations only if the information supplied by governments gave a detailed indication of all facilities available for training. The United Nations Educational, Scientific and Cultural Organization would have to be consulted since the question was within its competence. Speaking in his personal capacity, Dr. Tchang suggested that the International Union of Geodesy and Geophysics could easily publish such a list in its quarterly bulletin.

Mr. LACLAVÈRE (France) replied that he would be ready to undertake the preliminary research and the publication of such a list if the Cartographic Office of the United Nations was prepared to extend its co-operation.

Dr. TCHANG (Executive Secretary for the Conference) said that he had no doubt the Cartographic Office would give its co-operation as far as it was possible to do so.

Dr. SCHERMERHORN (Netherlands) wondered who could control the accuracy of such a list. Experience with the questionnaire addressed to the governments about the panel of experts on cartography had showed that the answers lacked homogeneity.

The CHAIRMAN felt that it was difficult to formulate a constructive conclusion to the debate on item 8 of the agenda. The Conference might say that it had taken note of the statements made by various representatives in respect of their requirements for technical assistance and the difficulties they were experiencing in obtaining it. Methods for facilitating procedures to obtain technical assistance had been outlined.<sup>2</sup> It was to be hoped that, in due time, the Technical Assistance Administration might have a continuing budget which would enable this branch of the United Nations to project long term plans.

#### Adoption of a standard method of writing geographical names on maps [Item 6 (b) of the agenda]

The CHAIRMAN emphasized that this subject was a vast one and that it might entail a long discussion, with no certainty of obtaining practical results. Some countries had already adopted the proposals formulated by the International Civil Aviation Organization or the International Hydrographic Bureau, but uniform-

<sup>2</sup> For the text of the resolution on technical assistance questions, adopted by the Conference at its seventh plenary meeting, see *Report of the Conference*, pages 17 to 18.



ity, or even a clear desire to obtain uniformity, was still nowhere in sight.

Replies received from governments<sup>3</sup> showed that the problem could be subdivided. Agreement was fairly general on the point that the local spelling should be given for names in languages using the Roman script. For other languages, it was hard to see what progress could be made until a body, set up under United Nations sponsorship, could establish a phonetic script and rules for transliteration applying to all the scripts of the world. This problem went beyond the competence of the Conference.

Lieutenant Commander MAULAWIN (Philippines) stated that his country approved the use of standard geographical names on maps, followed by the local versions in brackets. The Philippines was in favour of the system proposed by the International Hydrographic Bureau.

Mr. DHAVAN (India) agreed with the remarks made by the Chairman. It was highly desirable to adopt an identical Romanization for international maps. However, the value of graphic symbols differed from one language to another. One solution might be adding to these maps an elaborate index, on the model of the one annexed to the international map of the world on the millionth scale, but extended to the languages of all the countries on the map. As for languages which were not using Roman script, it was possible to adopt a uniform transliteration method. Such a system already existed in India and could be extended to other languages without major difficulty.

Mr. ELSTER (Israel) favoured the mention on the map of the local version of the name, with the exception of a few internationally known terms.

<sup>3</sup> See part II of this report, page 42.

Colonel PETTIT (United States of America) thought no progress could be made on the matter as long as groundwork had not been done on the linguistic and phonetic planes. He referred the representatives to the Conference document<sup>4</sup> in which the United States had indicated its willingness to co-operate in drafting a general framework for a programme looking towards maximum international uniformity in the writing of geographical names.

Rear-Admiral NICHOLS (International Hydrographic Bureau) noted that, of the eighteen nations represented at the Conference, twelve were members of the Bureau. The States members of the Bureau, and in addition the Philippines, had adopted certain fundamental rules on the handling of geographic names on charts. It seemed reasonable, until the United Nations had adopted some rule concerning this subject, that cartographers and hydrographers of various countries should get together and that the progress already made on hydrographic charts should be continued on maps.

The CHAIRMAN agreed with Rear-Admiral Nichols. The uniformity already existing would of course be taken as a basis for any future work. The Conference appreciated the fact that difficulties were numerous and that nothing could be done until some organization started on this difficult task and the offer of co-operation of the United States was accepted by other countries. The Conference could take note of the United States proposal and recommend that countries—especially the countries of the region—should consider what they could do to co-operate with the United States for the solution of this problem.

The meeting rose at 4.20 p.m.

<sup>4</sup> See footnote 3.

## SUMMARY RECORD OF FIFTH PLENARY MEETING<sup>1</sup>

Held at Savoy Hotel, Mussoorie, India, on Wednesday, 23 February 1955, at 10 a.m.

### CONTENTS

	Page
Organization of work .....	15

*Chairman:* Brigadier I. H. R. WILSON (India)

#### Organization of work

The CHAIRMAN stated that the meeting had been convened upon the request of several delegations as some of them had proposed the inclusion on the agenda of an item from the provisional agenda.

Issued as E/CONF.18/SR.5.

Mr. SUWANKATE (Thailand) proposed to include on the agenda the item "Limits of mapping responsibility for the International Map of the World on the Millionth Scale series". This item was of great interest to his country, which bordered on four other countries.

*The proposal was accepted.*

The CHAIRMAN stated that the item would be numbered 6 (g) (iii) and would be allocated to Committee IV.

The meeting rose at 10.10 a.m.

# SUMMARY RECORD OF SIXTH PLENARY MEETING<sup>1</sup>

Held at Savoy Hotel, Mussoorie, India, on Wednesday, 23 February 1955, at 2.30 p.m.

## CONTENTS

	Page
Organization of international co-operation .....	16

Chairman: Brigadier I. H. R. WILSON (India)

### Organization of international co-operation [Item 7 of the agenda]

- (i) Procedure for obtaining from adjacent countries information and mapping material in cases where the international mapping responsibility of one country extends over the territory of another country

The CHAIRMAN pointed out that the discussion which had taken place in Committee IV thoroughly covered the question, at least as far as mapping material was concerned. As to obtaining information, this would certainly be done through the channels established for the communication of mapping material. Consequently, he proposed that, on this point, the Conference should take into account the conclusions reached by Committee IV on item 6 (g) (iii) of the agenda.

- (ii) The establishment of an inter-governmental cartographic organization to work out uniform international cartographic standards and to give the necessary aid to less developed countries, as done by other inter-governmental organizations, so that the survey of the world may be expedited

The CHAIRMAN, before giving the floor to the representative of Burma, who had sponsored this item, drew the attention of the Conference to the document<sup>2</sup> which contained the views of the Netherlands on this question.

U MAUNG (Burma) was saddened to see that, in spite of the universal recognition of the importance of cartographical work and the technical advances achieved in that field, many regions of the world remained totally or partially unsurveyed. It would be superfluous to insist on the need to expedite the survey of the world as everyone knew that maps were essential to almost every aspect of modern living and that the development of the economic resources of the world was rapidly becoming more and more dependent on accurate maps.

Inequalities in various spheres, such as agriculture, health and education, had necessitated the formation

of inter-governmental organizations whose task it was to assist the less developed countries. Cartography was no exception: it was a well-known fact that in some countries no primary system of geodetically fixed control points existed. Consequently, Burma felt a very strong need for an inter-governmental cartographic organization which would provide necessary assistance to less developed countries.

In its report,<sup>3</sup> the Committee of Experts on Cartography had pointed out that the absence of an international cartographic organization was one of the causes of the unsatisfactory position of cartography. It had also demonstrated that national governments failed to appreciate the fundamental need for maps and were unable to provide adequate funds for mapping. In both these respects, the action of an international inter-governmental organization might be most helpful.

Such an organization would be the most effective medium to establish uniform international cartographic standards in respect of scales, projections, symbols and nomenclature. The International Civil Aviation Organization had already done this for aeronautical charts but, strangely enough, the maps on which these charts were based varied widely in almost every cartographic feature. Standard maps would give the peoples of the world a common medium in which to express the physical features of each country and on which to plan their economic life.

Finally, an international organization would permit the less developed countries to overcome the obstacle which they encountered at present in their efforts to obtain technical assistance. As Dr. Schermerhorn had pointed out, while some assistance was being given in that field, competition among various services for technical assistance was very keen and it was increasingly difficult to obtain assistance in cartography.

Answering a question of the CHAIRMAN, U MAUNG pointed out that he had in mind an inter-government organization on the world plan and not on a region plan.

Dr. SCHERMERHORN (Netherlands) made some general remarks on points which had come up during the discussion held at the Conference. The main difficulty encountered by cartographers was that the task was considered by many government officials to be of slight importance. The only way for the countries of the region to improve this situation was to demonstrate the direct importance of cartography for every

<sup>1</sup> Issued as E/CONF.18/SR.6.

<sup>2</sup> See part II of this report, pages 82 and 83.

<sup>3</sup> *Modern Cartography: Base Maps for World Needs.*

tion. In Europe, many countries, members of the International Union of Geodesy and Geophysics, had undertaken considerable work purely from the point of view of research and scientific development. Such an approach would be wrong for the countries of the region. Government officials would be convinced of the necessity for undertaking cartographic work and making budget appropriations for this purpose only if the close relation between cartography and economic development was established, and if they were given concrete examples of projects which had failed because of the lack of adequate maps or sufficient statistical information. They were not willing to pay for scientific objects which, at this stage of development, could be considered only as matters of prestige.

As to the development of international co-operation by means of international organizations, this question had been fully discussed by the Committee of Experts for Cartography which had met in April 1949 and in which Dr. Schermerhorn had been a member. The committee had drafted its recommendations in that respect with the utmost care, but perhaps it still had not been careful enough since the United Nations, in spite of the existence of the Cartographic Office and the hard work of its staff, had not done all that the experts believed it was essential to do.

Of course, important activities on the plane of international co-operation had been carried out by scientific organizations. However, given especially the insufficient support on the part of governments and the increased importance assumed by international organizations, the existence of such an organization in the field of cartography, on a fairly stable basis, was an absolute necessity.

The experience of the European Organization for Experimental Photogrammetric Research, which comprised seven countries of Europe, showed the advantages of inter-governmental work over that accomplished by international organizations of a private character. Governments had recognized the element of international co-operation, credits had been made available, and extremely important financial contributions had been made, especially by Italy, Switzerland and Austria. The results of this work would receive due publicity at the 1956 Congress of the International Society of Photogrammetry in Stockholm.

What could be done on the regional plane? As Dr. Schermerhorn had already pointed out at other meetings, the Conference was to discuss not so much technical as policy questions. Its task was to provide cartographers with means to persuade governments of the importance of their work. For this reason it was essential to strengthen the activities of the United Nations, not at Headquarters, but in the field, by giving the regional conference a permanent character. It might meet every three or four years. The present Conference was a first experience for everyone on the organization of subsequent sessions.

The CHAIRMAN thanked Dr. Schermerhorn for his most objective and most interesting statement.

Dr. MIYABE (Japan) stated that if an international cartographic organization came into existence, it might

help to eliminate the present discrepancies which existed at border lines due to the fact that in different countries different co-ordination systems and sets of references were used for control points. International co-ordination could be achieved on the basis of sufficient astronomical work (observations of occultations) and data in the field of triangulation, levelling and measurements of geomagnetism. An international organization would promote these activities, which were at present insufficient in many parts of Asia and the Far East. It would also emphasize the fact that geodetic and geophysical work was necessary not only for cartography but also for the general development of natural resources. It was to be hoped that technical assistance in this field would be included in the terms of reference of such an organization, the general activity of which might usefully follow the lines advocated by Dr. Schermerhorn.

Mr. ELSTER (Israel) wondered whether the proposal for establishing an inter-governmental organization would not lead to duplicating the work of existing international scientific organizations.

Dr. SCHERMERHORN (Netherlands) did not think so. First of all, the European inter-governmental organization dealt only with photogrammetry, and not with matters of wider scope covered by the International Union of Geodesy and Geophysics. Nor did it interfere with the International Society of Photogrammetry in general, whose articles on scientific and technical matters were published under the sole responsibility of their authors. The main interest in having an official inter-governmental organization was to achieve centralization and objective criticism of experimental results. It offered the only means to obtain statistical data on a comparative basis. This showed that there was a very sharp difference between the action of official inter-governmental organizations and private work such as that conducted by the International Society of Photogrammetry. The existence of an inter-governmental organization also strengthened the position of national institutes with their own governments. Dr. Schermerhorn felt certain that the creation of the European inter-governmental organization had in fact greatly promoted the work of the International Society of Photogrammetry, as would no doubt appear at the 1956 Congress in Stockholm.

The CHAIRMAN felt it was generally agreed that it was desirable to set up inter-governmental regional organizations and to continue to hold regional cartographic conferences. He agreed with Dr. Schermerhorn that inter-governmental organizations strengthened the hand of national cartographic institutes with their own governments. As regards the remarks of Dr. Miyabe, he felt that lack of uniformity in standards and practices used in neighbouring countries could be better dealt with by inter-governmental organizations on a regional basis. However, he wondered where funds could be found for the creation of such inter-governmental regional organizations.

Dr. SCHERMERHORN (Netherlands) said that, as he had been considering regional organizations within

the framework of the United Nations, all financial burdens should be borne by the United Nations. He insisted upon the specifically regional character of the conferences or organizations he referred to, and felt that representatives of countries outside the region concerned should be invited only as observers. In any case, the Economic and Social Council should be requested to provide all necessary means for the convening of regional conferences, and it was essential to convince the Council that such conferences were indispensable, not only for countries of a particular region, but also for the proper functioning of the Council itself.

Dr. TCHANG (Executive Secretary for the Conference) recalled that representatives present at the Conference had been invited by the Secretary-General of the United Nations in pursuance of a recommendation by the Committee of Experts on Cartography,<sup>4</sup> according to which representatives of countries of the region and of countries having an interest in the region should be invited.

Concerning the financing of United Nations cartographic conferences, the matter had to be discussed by the Economic and Social Council and by the General Assembly of the United Nations. These bodies were composed of representatives of governments.

Mr. MILLER (Canada) felt that cartography was sufficiently useful to provide arguments capable of convincing governments and the Economic and Social Council.

Rear-Admiral NICHOLS (International Hydrographic Bureau) considered that, if it was the general wish to create a regional inter-governmental organization, constructive steps should be taken to this end. For instance, the Conference might set up an office to draft the status and objects of the said organization and to forecast expenses. This office could then send a detailed statement to governments, which would thus be in a position to take a direct decision.

Dr. SCHERMERHORN (Netherlands) thought that, although some centralization would no doubt be indispensable, the regional organizations envisaged were not comparable to the International Hydrographic Bureau. First, they should be established within the framework of the United Nations. Secondly, cartographic conditions and interests differed widely in the various regions of the world, so that regional organizations would probably be more effective than a single world organization. Experience had also shown that regional meetings commanded wider attendance than meetings of world organizations.

The CHAIRMAN suggested that the Executive Secretary for the Conference and himself draft a recommendation stating that the Conference recognized the necessity of creating inter-governmental organizations on a regional basis, within the framework of the United Nations, in order to impress upon governments the necessity of progress in all fields of cartography, and that the best means to achieve this would be to work on the basis of regional cartographic conferences.

<sup>4</sup> *Ibid.*

Upon a suggestion by the CHAIRMAN, Mr. Miller proposed to add that the coming regional conferences should also consider ways and means of establishing inter-governmental cartographic organizations for their regions.

*It was so decided.*

(iii) Questions relating to a central research organization or office to which problems can be referred and from which up-to-date information about various instruments may be obtained

U MAUNG (Burma) felt that the communication provided by his delegation<sup>5</sup> sufficiently stressed the reasons for creating a central research organization in the region. He wished to know the view of other delegations on the subject.

Dr. GIGAS (Federal Republic of Germany) referred delegates to the statement on the subject in the communication of the delegation of the Federal Republic of Germany.<sup>6</sup> One way of initiating work in this field would be to publish a regional journal, in which the various countries could state their problems and the subjects which interested them most.

Mr. DHAVAN (India) was also much in favour of the creation of a central research institute and approved the reasons set out in the Burmese documents.<sup>7</sup>

Mr. MILLER (Canada) felt that implementation would be accelerated by considering first a central organization to which problems could be referred and where up-to-date information about various instruments could be obtained, instead of ambitiously considering from the very start the creation of a "central research organization".

Mr. ELSTER (Israel) thought that it was difficult to speak of the creation of a central organization before defining the exact function and constitution of such an organization. The question should be thoroughly investigated and referred to the next regional cartographic conference.

Dr. SCHERMERHORN (Netherlands) agreed with Mr. Elster and Dr. Gigas that the creation of a central organization was not an easy matter. Many effort had been made in this direction in Europe and it had proved impossible, and perhaps unnecessary, to establish a central institute. The problem was mainly one of co-operation between the various governments but in any case it would be rather optimistic to expect great results in this field, especially in Asia, where distances were so much greater than in Europe. However, if the countries of the region did decide to create a central institute, the International Society of Photogrammetry would be glad to assist them in all possible ways in establishing it.

The CHAIRMAN, summing up the discussion, felt that the opinion of the Conference might be expressed along the following lines: the Conference felt the essential need of a central international organization on cartography, but also realized the difficulties involv

<sup>5</sup> See part II of this report, page 129.

<sup>6</sup> See part II of this report, page 77.

<sup>7</sup> See part II of this report, page 129.

the creation of such a body. Consequently, it favoured, as a first measure, the establishment of a committee or several committees specialized in a specific field. When they needed expert guidance, these committees were to approach the countries or the

institutions particularly competent in the matter. The Chairman, in co-operation with the Executive Secretary, would draw up the final text of a draft recommendation on that point.

The meeting rose at 4.35 p.m.

# SUMMARY RECORD OF SEVENTH PLENARY MEETING<sup>1</sup>

Held at Savoy Hotel, Mussoorie, India, on Friday, 25 February 1955, at 10.00 a.m.

## CONTENTS

	Page
Adoption of the report of the Conference .....	20
Resolutions of the Conference .....	20
Report of the Conference .....	22
Expression of thanks and closing of the Conference .....	22

Chairman: Brigadier I. H. R. WILSON (India)

### Adoption of the report of the Conference [Item 9 of the agenda]

The CHAIRMAN submitted the draft report prepared by the Drafting Committee.<sup>2</sup> It was decided to consider chapters I and II first.

*Chapters I and II were adopted without discussion.*

The CHAIRMAN indicated that the text of chapter III, summarizing the communications and debate relating to agenda items 5 to 8, was not yet ready. It also contained the draft resolutions. As soon as the text was completed, it would be sent to the officers of the Conference and its committees for checking and approval. He proposed that this chapter be considered as provisionally adopted.

*It was so decided.*

### Resolutions of the Conference<sup>3</sup>

The CHAIRMAN explained that the text of the resolutions in document E/CONF.18/B/L.1 had been prepared by the Drafting Committee on the basis of the reports of the four technical committees and the proposals submitted to the Conference. These draft resolutions would be considered singly.

#### RESOLUTION ON RECENT PROGRESS AND INTERESTING TECHNICAL DEVELOPMENTS IN THE RESPECTIVE COUNTRIES

The CHAIRMAN, referring to the discussions which had taken place in the Drafting Committee, proposed deleting the words "even the elements of" in the penultimate line of sub-paragraph (i).<sup>4</sup>

<sup>1</sup> Issued as E/CONF.18/SR.7.

<sup>2</sup> The Committee consisted of the following members: President, Vice-President, Executive Secretary, the Chairman of each of the technical committees and the head of the delegation of the United States of America.

<sup>3</sup> The texts of the resolutions, as adopted, may be found on pages 7 to 18 of Vol. 1, *Report of the Conference*.

<sup>4</sup> Sub-paragraph (i) of the draft resolution read as follows: "Having taken note of (i) the present state of progress of the various nations of this region in the cartographic

*With this amendment, the draft resolution was adopted and became resolution I of the Conference.*

#### RESOLUTION ON THE APPLICATION OF AIRBORNE ELECTRONIC DEVICES FOR THE CONNEXION WITH INDIA OF OUTLYING ISLANDS SUCH AS THE ANDAMANS AND NICOBARS

*The draft resolution was adopted without discussion and became resolution II of the Conference.*

#### RESOLUTION ON THE DESIRABILITY OF MEASURING ONE OR MORE STANDARD BASE LINES IN INDIA AND OTHER FAR EASTERN COUNTRIES WITH THE VÄISÄLÄ COMPARATOR DEVELOPED AT THE FINNISH GEODETIC INSTITUTE

*The draft resolution was adopted without discussion and became resolution III of the Conference.*

#### RESOLUTIONS ON MAGNETIC AND GRAVITY OBSERVATIONS IN THE BAY OF BENGAL AND THE ARABIAN SEA

*The two draft resolutions were adopted without discussion and became resolutions IV and V of the Conference.*

#### RESOLUTION ON THE MAINTENANCE OF "NATIONAL MAGNETIC STANDARD INSTRUMENTS" AND THEIR COMPARISON WITH EUROPEAN STANDARDS

*The draft resolution was adopted without discussion and became resolution VI of the Conference.*

#### RESOLUTION ON FIRST-ORDER TRIANGULATION AND LEVELLING CONNEXIONS BETWEEN NEIGHBOURING COUNTRIES (E.G., IRAN, IRAQ, SYRIA AND TURKEY)

Mr. LACLAVERE (France) suggested that, in order not to use a word with two different meanings, *respe* be substituted for *connexion* in the last line of paragraph 4.<sup>5</sup>

*With this amendment, the draft resolution was adopted and became resolution VII of the Conference.*

#### RESOLUTION ON MEANS OF OBTAINING A REGULAR SMALL-SCALE PHOTOGRAPHIC COVERAGE IN THE SECTORS OF A REGION WHERE SUCH COVERAGE DOES NOT YET EXIST OR WHERE IT APPEARS TO BE INSUFFICIENT

Colonel PETTIT (United States of America) wondered whether it would not be advisable, in the le

field, both as regards the methods in use in each country and in respect of the great leeway required to be made up in the various cartographic fields before even the elements of cartographic self-sufficiency can be achieved."

<sup>5</sup> References to paragraphs and lines as given here to the resolutions in their printed form.

paragraph, to replace the words *vital necessity by* *irability*.

The CHAIRMAN stated that an identical proposal had been discussed in the Drafting Committee and a consensus of opinion had been that a strong expression must be used.

Mr. MILLER (Canada), Dr. SCHERMERHORN (Netherlands) and Mr. LACLAVERE (France) supported this point of view.

*The draft resolution was adopted as submitted and became resolution VIII of the Conference.*

RESOLUTION ON THE MOST APPROPRIATE INSTRUMENTS AND METHODS TO ENSURE THE RAPID EXECUTION OF CARTOGRAPHIC SURVEYS OF AVERAGE PRECISION AND AT A SCALE OF THE ORDER OF 1:50,000 OR 1:100,000 BY THE USE OF AERIAL PHOTOGRAPHS IN COUNTRIES WHICH ARE NOT YET PROVIDED WITH REGULAR MAPS

*With a drafting change proposed by the Chairman, the draft resolution was adopted and became resolution IX of the Conference.*

RESOLUTION ON IMPROVEMENT AND STANDARDIZATION OF CADASTRAL SURVEY METHODS

Dr. SCHERMERHORN (Netherlands) pointed out that, through a material mistake, sub-paragraph (e) had been omitted from the text given in document CONF.18/B/L.1. He proposed to re-establish the correct text of the draft resolution by adding the missing paragraph.

*With this correction, the draft resolution was adopted and became resolution X of the Conference.*

RESOLUTION ON ADOPTION OF A STANDARD METHOD OF WRITING GEOGRAPHICAL NAMES ON MAPS

Colonel PETTIT (United States of America) proposed that, for the sake of clarity, the last paragraph of the draft text which read:

"2. *Recommends* that the governments of this region should appoint experts to participate in the deliberations of a committee to be set up under the United Nations, on the lines proposed by the Government of the United States of America."

be replaced by the following:

"2. *Recommends* that a committee should be set up under the auspices of the United Nations, on the lines proposed by the Government of the United States of America, and that the governments of this region should appoint experts to participate in the deliberations."

Mr. MILLER (Canada) supported this proposal.

*With this amendment the draft resolution was adopted and became resolution XI of the Conference.*

RESOLUTION ON TOPICAL MAPS

Mr. GEORGE (Food and Agriculture Organization) proposed in connexion with this draft resolution that an amendment be made to the text of the report of Committee III. In paragraph 10, line 4, the words

however as were to be omitted and on line 5 *require* should replace *required*.

*This proposal was accepted.*

*With this understanding the draft resolution was adopted and became resolution XII of the Conference.*

RESOLUTION ON HYDROGRAPHY

Rear-Admiral NICHOLS (International Hydrographic Bureau) pointed out that in the third paragraph of the draft resolution *statute 11* should be substituted for *statute II*.

*With this correction, the draft resolution was adopted and became resolution XIII of the Conference.*

RESOLUTION ON AERONAUTICAL CHARTS AND INTERRELATION OF ICAO 1:1,000,000 SERIES AND THE INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE

Colonel PETTIT (United States of America) suggested that, in the second line, *are designed* be substituted for *catered* and *is* for *was*.

*With these changes, the draft resolution was adopted and became resolution XIV of the Conference.*

RESOLUTION ON STANDARDIZED SPECIFICATIONS FOR THE INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE

Mr. MILLER (Canada) wished to know the opinion of the representatives of the region concerning the clause "While the major items, such as projection, sheet lines, etc. would be made mandatory".

Mr. DHAVAN (India) felt that major items such as sheet lines should be uniform, as otherwise no agreement would be possible on other conventions. He therefore approved the clause mentioned.

Mr. GEORGE (Food and Agriculture Organization) thought that Mr. Miller's query was justified. He believed that the predominant opinion of the countries of the region should be followed.

Mr. PARK (International Civil Aviation Organization) noted that the draft resolution seemed to imply that there was a special organization for the revision of IMW specifications. This was not so, and it should be reflected in the resolution.

The CHAIRMAN observed that this point was already covered in paragraph 13 on the report of Committee IV.

Mr. PARK (International Civil Aviation Organization) nevertheless thought that the draft resolution should be clarified in the sense he had indicated.

The CHAIRMAN accordingly proposed to add to the draft resolution a second paragraph identical with paragraph 13 of the report of Committee IV, with the exception of the first four words. The paragraph would read as follows:

(b) That it would be desirable for the Secretary-General of the United Nations to appoint an advisory committee of experts to examine proposals on the specifications for the IMW series received from countries. The findings of the committee should be transmitted to governments for consideration before final



adoption by an international conference to be convened by the United Nations.

*With this amendment, the draft resolution was adopted and became resolution XV of the Conference.*

#### RESOLUTION ON LIMITS OF MAPPING RESPONSIBILITY FOR THE INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE

Mr. DHAVAN (India) proposed to insert the word *land* between *largest portion of* and *territory* in the last sentence of paragraph (a).

*With this amendment, the draft resolution was adopted and became resolution XVI of the Conference.*

#### RESOLUTIONS ON ORGANIZATION OF INTERNATIONAL CO-OPERATION

The CHAIRMAN noted that the question of procedure for obtaining from adjacent countries information and mapping material in cases where the international mapping responsibility of one country extended over the territory of another country had already been adequately covered by resolution XVI, just adopted. The Conference had before it two other draft resolutions. One dealt with the establishment of an inter-governmental cartographic organization to work out uniform international cartographic standards and to give the necessary aid to less developed countries, as done by other inter-governmental organizations, so that the survey of the world might be expedited. The other concerned questions relating to a central research organization or office to which problems could be referred and from which up-to-date information about various instruments might be obtained.

*These draft resolutions were adopted without discussion and became resolutions XVII and XVIII of the Conference.*

#### RESOLUTION ON TECHNICAL ASSISTANCE

*The draft resolution was adopted without discussion and became resolution XIX of the Conference.*

#### RESOLUTION ON SECOND UNITED NATIONS REGIONAL CARTOGRAPHIC CONFERENCE FOR ASIA

The CHAIRMAN then submitted the draft resolution regarding the convening of a second regional cartographic conference for Asia and the Far East.

*The draft resolution was adopted and became resolution XX of the Conference.*

#### Report of the Conference

The CHAIRMAN stated that, since the resolutions presented by the Drafting Committee had now been adopted, all that remained was to adopt chapter III, subject to any minor changes that might be made by the officers when the text was available, and then the report of the Conference as a whole.

*There being no objection, chapter III was adopted, and the report of the Conference was adopted.*

#### Expression of thanks and closing of the Conference

The CHAIRMAN thanked the Executive Secretary, the staff from United Nations Headquarters and from the Economic Commission for Asia and the Far East for their valuable work in the Conference. He expressed the representatives' gratitude to Colonel Gambhir Singh and the personnel of the Survey of India for the excellent arrangements they had made for the success of the Conference. He also was grateful for the good will of the countries outside the region who had sent highly qualified experts to the Conference.

Mr. MILLER (Canada) expressed the Conference's appreciation of the very courteous hospitality and efficient organization provided by the host country, India.

The CHAIRMAN thanked all delegates for their co-operation and in particular he thanked the officers of the committees. He felt certain that the personal contact initiated in the Conference would prove fruitful for future cartographic work.

Dr. TCHANG (Executive Secretary for the Conference), in the name of the Secretary-General of the United Nations and in his own name, thanked the Chairman and all delegates for their good will and co-operation and expressed the Organization's gratitude to Colonel Gambhir Singh, Mr. Ramanathan and all other members of the Survey of India for their invaluable assistance in making all the arrangements and in providing all necessary services.

The CHAIRMAN declared closed the United Nations Regional Cartographic Conference for Asia and the Far East.

The meeting rose at 11 20 a.m.

## **Part II**

### **TECHNICAL DOCUMENTS PRESENTED TO THE CONFERENCE**

# INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE : MEANS OF BRINGING THE TASK TO COMPLETION

by

*Secretariat of the United Nations*

The original text of this paper appeared as document E/2376 under the title "Means for Furthering the Completion of the International One-Millionth Map of the World")

## TERMS OF REFERENCE

At its thirteenth session, the Economic and Social Council adopted resolution 412 A II (XIII):

" *The Economic and Social Council,*

" *Having examined* the report of the Secretary-General on relations with inter-governmental organizations,

" *Desiring* to give further effect to its resolutions concerning the termination or integration of certain intergovernmental organizations,

" *Considering* that the United Nations Cartographic Office has been established and is capable, within present budgetary limitations, of performing the functions hitherto carried on by the Central Bureau of the International Map of the World on the Millionth Scale,

" 1. *Requests* the Secretary-General to invite the President of the Central Bureau to seek the assent of those governments which have maintained contact with the Central Bureau since the end of World War II to transfer the work of the Central Bureau to the United Nations Cartographic Office;

" 2. *Calls upon* the Secretary-General, in collaboration with the President of the Central Bureau, to effect the transfer of the records, documents, maps and assets of the Central Bureau to the United Nations Cartographic Office at the earliest practicable date, and to report the action taken thereon to an early session of the Council; and

" 3. *Requests* the Secretary-General to submit recommendations to an early session of the Council on appropriate means for furthering the completion of the international map of the world on the millionth scale, taking into account the views of such consultants on cartographic questions as he may wish to seek."

This report is prepared in accordance with paragraph 3 of the above resolution.

## INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE

The international map of the world on the millionth scale (referred to as "international map of the world")

or as IMW) is a project being carried out in accordance with resolutions adopted by representatives of governments at international conferences in 1909 and 1913; several minor amendments to the specifications were introduced in 1928. The actual preparation and publication of the sheets are the responsibility of the country or countries concerned. The resolutions of the conferences dealt not only with procedures but also with detailed specifications concerning sheet area and sheet lines; projections; hypsometric colours and contours; lettering, spelling and transliteration of names; conventional signs and colours, and other technical features.

The Convention of 1913 set up the Central Bureau of the International Map of the World on the Millionth Scale<sup>1</sup> to serve as a liaison between governments for exchange of information and to assist governments in co-ordinating publication of the map in standard form.

The international map, which comprises nearly 1,000 sheets for the land areas of the world, is a long-term international project. The work twice suffered interruption because of world wars. Calculations based on the latest report of the Central Bureau, issued in 1952, and the number of maps received by the United Nations Secretariat, indicate that a few more than 400 sheets have been completed, but many of them need to be brought up to date.<sup>2</sup> In this connexion, mention may be made of the fact that, since adoption of the recommendation for transfer of the Central Bureau to the United Nations, some national map producing agencies have hesitated to resume their work in this field until the United Nations intentions regarding publication of the map are made known.

## CONSULTATIONS

In preparing this study, efforts have been made to secure opinions from experts in various parts of the world, reflecting, as far as possible, the various points of view and, in particular, views of (a) officials of

<sup>1</sup> The transfer of the Central Bureau to the United Nations, recommended by the Economic and Social Council, was completed by 30 September 1953.

<sup>2</sup> An index map showing the status of publication in 1952 appears between pages 38 and 39.

international organizations dealing with this project since its inception, such as the Central Bureau and the International Geographical Union (IGU), and (b) officials of national cartographic agencies responsible for the preparation and publication of the international map and representing the viewpoint of countries with differing degrees of development in cartography as well as those with widely different cartographic requirements. Excerpts from the replies appear in annex B. Furthermore, the findings of the International Geographical Union and the VIth Pan American Consultation on Cartography in regard to questions on the international map have been taken into account in this report.

In pursuance of its consistent interest in promoting and developing the international map, the International Geographical Union at its VIIth Assembly, held in Lisbon in 1949, established a new Commission on the International Map of the World, 1:1,000,000. Its terms of reference were to consider comprehensively the problem of the international map and, in particular, (a) to consider what changes, if any, should be made in the Central Bureau; (b) to advise whether the absorption or integration of the Central Bureau by the United Nations would be advantageous; (c) to ascertain what coverage at the one-to-one million scale exists or is in course of preparation, and to advise whether duplication of effort, if any, can be advantageously reduced (with particular reference to the World Aeronautical Chart of the International Civil Aviation Organization (ICAO) on the millionth scale); (d) to review the present procedure whereby each nation produces, to a generally agreed specification, sheets covering a specific area, and to recommend whether or not any change in this procedure is worthy of further investigation; (e) to reappraise the purposes for which the international map of the world on the millionth scale was originally created and to ascertain how far the present specifications, including sheet layout, meet modern requirements, and particularly whether a base map suitable for carrying geographical overprints can satisfactorily be printed from the various existing plates; (f) to ascertain how far the ICAO World Aeronautical Chart on the millionth scale can meet the purposes for which the international map of the world is produced and vice versa, and whether any co-ordination between the two could be effected with advantage.

The Commission made two inquiries by circular letters to the officials responsible for the international map of the world in various countries, with a view to assembling fundamental facts and official opinions needed as a basis for recommendations. Dr. J. K. Wright, Chairman of the Commission, made available to the Secretariat of the United Nations the Commission's report,<sup>3</sup> together with photostatic copies of replies received from the following countries: Argentina, Australia, Belgian Congo, Belgium, Canada, Denmark, Dominican Republic, Ecuador, Egypt, Finland, France, French West Africa, western Germany, Guatemala, Iceland, India,

Indochina, Indonesia, Ireland, Italy, Japan, Monaco, Netherlands, New Zealand, Norway, Pakistan, Portugal, Southern Rhodesia, Sudan, Sweden, Switzerland, Thailand, Union of South Africa, United Kingdom of Great Britain and Northern Ireland, United States of America, Venezuela and Yugoslavia.

The report of the Commission was examined at the VIIIth Assembly of the International Geographical Union, held jointly with the XVIIth International Geographical Congress in August 1952 in Washington, D.C. After debate, the Commission adopted a resolution<sup>4</sup> recommending that the International Geographical Union take several actions for supporting and developing the international map of the world.

The VIth Pan American Consultation on Cartography, held in October 1952 in Ciudad Trujillo, Dominican Republic, adopted resolutions<sup>4</sup> calling for appropriate action by governments of the American nations and by the Pan American Institute of Geography and History to promote and to facilitate publication of the international map of the world.

#### ANALYSIS OF PROPOSALS

The following paragraphs summarize the findings of the international organizations and the views expressed by experts on the major issues concerning future development of the international map of the world on the millionth scale.

#### BASIC POLICY QUESTIONS

With respect to arrangements for production of the international map, the report of the IGU Commission favoured continuing to decentralize the operations to individual nations. The president of the Central Bureau suggested further that the United Nations Cartographic Office should endeavour to secure the greatest amount of co-operation between countries; expedite the free exchange of maps and material required for the project; organize—rather than provide—assistance to those nations which have limited mapping resources or none; endeavour to minimize the duplication of effort which may occur when the territories of more than one nation impinge on a single sheet of the international series; maintain close touch with national mapping organizations, with other international mapping organizations such as the International Civil Aviation Organization and with all similar mapping projects in progress or planned.

Mr. H. A. Baumann, Director, Trigonometrical Survey of the Union of South Africa, pointed out that the mapping resources possessed by small nations (and even some of the great ones) were strained to the limit in keeping abreast of domestic mapping requirements and suggested that the work of producing the international map of the world must, as far as possible, be integrated into the domestic mapping programme of each nation.

Mr. R. Verlaene, of the Belgian Institut géographique militaire, a member of the Committee of Experts,

<sup>3</sup> The edited text is reproduced in annex A.

<sup>4</sup> Reproduced in annex A.

on Cartography called by the Secretary-General to meet in 1949, expressed the view that a survey should be undertaken by the United Nations to secure, by means of a detailed questionnaire to governments, an inventory of the existing completed sheets, as well as of the possibilities and means in various countries for carrying on the work, and an indication of their wishes as to the manner in which the project should be continued. On the basis of the replies received, it would be possible to decide on measures to be taken and to establish an appropriate programme for the work of the United Nations in this field.

#### *Stimulation of Interest*

Interest in the international map of the world has been considered an essential factor in furthering its publication. Mr. Verlaine stressed the importance of the reaffirmation by geographers of the need for completion of the map and of their scientific and practical interest both currently and in the future.

The president of the Central Bureau considered it most necessary that all those nations which adhere to the conventions dealing with the international map of the world should continue to be served and be made to feel that they could continue to take part in this international project after the Central Bureau had been transferred to the United Nations.

General Salwidhan Nidhes, Director of the Aerial Mapping Organization of Thailand, stated that appropriate measures should be taken to enable the United Nations to take over the functions of the Central Bureau, thus obtaining better co-operation and accelerating production of the map.

Both the International Geographical Union and the VIth Pan American Consultation on Cartography urged governments to bear in mind the international map of the world in planning their cartographic programmes. The Pan American Consultation recommended that governments of the American nations report on progress to the next session scheduled for 1954.

#### *Revision of Specifications*

While views had been expressed that no modification should be made in the existing character of the map, the international organizations and the experts consulted seemed to concur in the necessity for a revision of the specifications which govern its publication and which were adopted at intergovernmental conferences. The IGU Commission recommended that the International Geographical Union give support to action that would facilitate international agreement upon the measures necessary to keep the specifications and production of the international map of the world continuously in line with modern international requirements as well as with the particular needs of each country. The VIth Pan American Consultation on Cartography invited the Pan American Institute of Geography and History to recommend to the United Nations a study of the specifications for up-to-date revision in the interests of pertinent international agreement. In addition,

many views were expressed in favour of making the specifications more flexible. Nevertheless, opinions were diverse as to the specific items to be revised as well as the modifications to be made; projections, sheet lines, geographical names were among the items proposed. On several technical questions and on questions of policy the inquiries made by the International Geographical Union revealed such wide differences of views that the IGU Commission itself found it impossible to formulate conclusions that would reflect any consensus of opinion.

As to the procedure for carrying out such revision and for discussing the problems relating thereto, the IGU Commission's report recommended the holding of a conference of representatives of the governments which have undertaken or were otherwise interested in the production of the international map. At this conference the international map of the world would be considered in all its aspects, and definite policies and specifications concerning it would be established. Subsequently, the Commission recommended that the International Geographical Union set up a committee of cartographic experts to be available to advise the United Nations on matters relating to the international map as needed.

General L. Hurault, Director of the Institut géographique national of France was of the opinion that the problems relating to the completion of the international map could hardly be solved by correspondence. This opinion corresponded with that of the Commission. He suggested that it would be advisable to have a meeting of experts to study the various aspects and to make recommendations when the results of the inquiries already in progress were available.

#### *Financial Problems*

General Hurault drew attention to the financial aspects of the publication, especially in the case of governmental agencies confronted by reduced budgets and responsible for the production of many sheets covering extensive areas. He expressed the view that a subvention from the United Nations to publishing agencies would be desirable. The IGU Commission considered that such a procedure might, however, detract from the international and cooperative nature of the undertaking and recommended that the agencies invited to attend the proposed international conference be asked, well in advance of the meeting, to consider and be prepared to present their views with regard to this problem both in general terms and more specifically as to the desirability of seeking subventions from the United Nations.

#### CONCLUSION

On the basis of the findings of the International Geographical Union and the VIth Pan American Consultation on Cartography together with the opinion of experts as set forth in this report, the Secretary-General will continue to maintain close liaison with the responsible national cartographic agencies and the interested international organizations for the purpose

of furthering the completion of the international map of the world on the millionth scale. One means to this end would be the preparation of proposals for

amending the existing specifications governing the publication of the map, with a view to their adoption by international agreements.

## ANNEX A

### Report and resolutions relating to the international map of the world adopted at international conferences

#### VIIth ASSEMBLY OF THE INTERNATIONAL GEOGRAPHICAL UNION (AUGUST 1952)

##### *Report of the Commission on the International Map of the World on the Millionth Scale*

At the meeting of the VIIth Assembly of the International Geographical Union held in Lisbon on 15 April 1949, a new Commission on the International Map of the World on the Millionth Scale was established. The Director-General of the Ordnance Survey of Great Britain, General G. Cheatham, Professor Leite de Castro of Rio de Janeiro, and Dr. John K. Wright of the American Geographical Society, New York, were named as members, with Dr. Wright as Chairman. After a few months of helpful service, General Cheatham was succeeded as Director-General of the Ordnance Survey—and therefore as Commission member—by General R. L. Brown. Upon the recommendation of the original commission the following were added in the autumn of 1949 as official members: General Louis Hurault, Director of the Institut géographique national of France, and Dr. F. J. Alcock, Chief Curator of the National Museum of Canada, Ottawa, and as corresponding members, Professor Henri Gaussens of the University of Toulouse, France, and Dr. Ronald Miller of the University of Edinburgh, Scotland.

In the autumn of 1949 the Commission adopted terms of reference for its guidance, which were approved by the Executive Committee of the International Geographical Union, as follows:

The duties of the Commission shall be:

1. To consider comprehensively the problem of the International Map of the World, 1 : 1,000,000;

2. In particular,

(a) To consider what changes, if any, should be made in the Central Bureau of the International Map of the World on the Millionth Scale;

(b) To consider and advise whether the absorption or integration of the Central Bureau would be advantageous in the light of the following resolution<sup>1</sup> adopted by the Economic and Social Council of the United Nations on 27 July 1949, under item 45, "Co-ordination of cartographic services of specialized agencies and international organizations":

"The Economic and Social Council,

"Having noted that a number of States have expressed views in favour of the absorption or integration of the Central Bureau, International One Millionth Map of the World into the United Nations,

"Requests the Secretary-General to examine the possibility of such absorption or integration in the light of the Council's decisions on the co-ordination of cartographic services."

<sup>1</sup> Resolution 261 B (IX).

(c) To ascertain what coverage at the millionth scale exists or is in course of preparation, and to advise whether duplication of effort, if any, can be advantageously reduced. Particular reference should be made to the ICAO aeronautical charts on the millionth scale;

(d) To review the present procedure whereby each nation produces, to a generally agreed specification, the sheets covering a specific area, and to recommend whether or not any change in this procedure is worthy of further investigation;

(e) To reappraise the purposes for which the IMW was originally created and to ascertain how far the present specification, including sheet layout, meets modern requirements, and particularly whether a base map suitable for carrying geographical overprints can satisfactorily be printed from the various existing plates;

(f) To ascertain how far the ICAO aeronautical charts on the millionth scale can meet the purposes for which the IMW is produced and vice versa, and whether any co-ordination between the two maps could be effected with advantage

The actions of the Commission in relation to these terms of reference are summarized here:

*Item 1* No specific comment on this item seems needed since the work done in connexion with item 2 involved comprehensive consideration of the problem of the IMW.

*Item 2 (a).*<sup>2</sup> In his paper on this item, after reviewing the origins of the IMW, the establishment of the Central Bureau, its duties and work, and the financial problem, General Brown emphasized the need for continuance of the bureau and pointed out that two alternative courses were open, namely:

(i) Functions of the Central Bureau to remain limited as at present;

(ii) Functions of the Central Bureau to be widened to include (a) the bringing forward of recommendations for revision of the specification regularly at suitable international congresses on mapping, such as the quadrennial meetings of the International Geographical Union; (b) the organization of special meetings to take such executive international action as may be necessary from time to time.

He then indicated the advantages and disadvantages of each course and made the following recommendation: In view of the large amount of revision required to the specification, entailing considerable work and effort, it is essential to adopt course (ii) at least for a period of years.

*Item 2 (b).*<sup>2</sup> In his paper on this item, General Brown recommended: That the attitude the International Geographical Union should adopt is to support the proposal for transference of the Central Bureau to the United Nations provided that the agreement of the adhering nations is first obtained.

<sup>2</sup> With regard to items 2 (a) and (b) General Brown prepared two comprehensive papers which were circulated to the Commission and commented upon.

arly in 1951 the Commission voted to approve the proposed transfer of the Central Bureau of the International Map of the World on the Millionth Scale to the United Nations. The Commission believes and recommends that the International Geographical Union should do everything in its power to facilitate the transfer.

On 20 September 1951, the Economic and Social Council of the United Nations adopted a resolution requesting the Secretary-General of the United Nations to take steps towards bringing about the transfer, and on 21 March 1952, General Brown, as President of the Central Bureau, addressed a letter to the various agencies responsible for production of the international map, requesting the assent of their representatives to this measure.

*Item 2 (d).* In a comprehensive discussion of this item, General Brown outlined the current procedure, characterized the problem as consisting "essentially of deciding what amount of decentralization is best for the production of the international map", discussed the various factors affecting the problem, and stated the advantages and disadvantages of three possible courses, namely:

- (i) To continue to decentralize production of the international map to each nation as at present;
- (ii) To decentralize production to each nation as at present, while at the same time retaining certain areas for production by a central cartographical establishment;
- (iii) To put the whole of the production of the map in the hands of a central cartographical establishment.

General Brown recommended: That there should be no change in the present procedure.

*Item 2 (e).* In a report on this item General Hurault expressed the opinion that the international map of the world was essentially a geographic map for general use and that the specification had been carefully established with this object in view. He held it to be absolutely necessary that the two types of maps represented by the international map and the world aeronautical charts should both be maintained, that production of the former should be pursued as diligently as possible, and that no modifications should be made in its existing character.

*Inquiries on items 2 (c), (d), (e) and (f).* Concerning these items the Commission made two inquiries with a view to assembling facts and expressions of opinions needed for consideration of the several matters in question. Each of the inquiries was carried out by addressing some fifty letters to the officials responsible for the international map of the world in the several nations, using for this purpose an address list supplied by General Brown.

*Inquiry I,* undertaken by Dr. Alcock in the spring of 1951 and designed primarily to secure information pertinent to items 2 (c), (d) and (e), sought to ascertain the dates when IMW sheets were published and the nature both of available reproduction materials and of sheets in preparation; he also called for suggestions that might be of interest to the Commission. Thirty-four replies were received.

*Inquiry II,* undertaken by Dr. Wright in the summer of 1951 and mailed to the same addressees as the first one, was designed to secure information pertinent to item 2 (f), namely with regard to the relationship between the international map and the ICAO world aeronautical charts. To the inquiry was appended a list of several proposals upon which comments were invited. Twenty-five replies were received.

Through these inquiries useful information and expressions of opinion with regard to technical matters were brought together; these are summarized in annex B to this

report.<sup>3</sup> The replies disclosed a large measure of agreement upon the point that there is a need for both the international map and the world aeronautical charts and that this need is especially great in the more densely settled parts of the world.

On other technical questions and on questions of policy, however, the inquiries revealed such wide differences of opinion that the Commission has found it impossible to formulate answers that would reflect any consensus. The Commission has thus become convinced that these problems are not capable of adequate consideration through correspondence and demand full discussion by conference. Accordingly the Commission recommends that, after the transfer of the Central Bureau has been effected, the United Nations would be well advised to hold a conference of representatives of the governments which have undertaken or are otherwise interested in the production of the international map at which the map would be considered in all of its aspects, and definite policies and specifications concerning it would be established.

This would appear to be all that the Commission can usefully recommend. If the suggested conference were to be held, the representatives of each nation would by then have a fairly good idea of the points of view held by other nations, and the conference would have some chance of reaching agreement.

The Commission has also given attention to two other matters not included in its terms of reference: (1) the question of the financing of the international map of the world and (2) the question of the relationship of the international map of the Roman Empire to the map of the world.

#### *Financing the International Map of the World*

The Commission believes that an important question of policy relates to the financing of the IMW, especially in the case of governmental agencies confronted by reduced budgets and responsible for the production on many sheets covering extensive areas. Were it possible and deemed desirable to secure subventions from the United Nations to this end, long delays in the production of the sheets for such areas might be avoided. Such a procedure might, however, detract from the international and co-operative nature of the undertaking. The Commission, accordingly, recommends that the agencies invited to send representatives to the proposed conference be asked well in advance of the meeting to consider and be prepared to present their views with regard to the problem of financing the IMW, both in general terms and specifically in terms of the desirability of seeking subventions from the United Nations.

#### *International Map of the Roman Empire*

In May 1952 the Chairman received from Lieutenant Colonel L. P. Kirwan, Secretary and Director of the Royal Geographical Society, London, a paper on the subject of the International Map of the Roman Empire (*Tabula Imperii Romani*) on the scale of one to one million. Initiated at the International Geographical Congress of 1928, at which a Commission was set up to deal with it, this enterprise was further organized at a Congress held for the purpose in London in 1935 at which resolutions were adopted recommending that (1) the preparation of the map

<sup>3</sup> The original replies to inquiry II and a set of copies of those to inquiry I have been deposited in the Library of the American Geographical Society, New York City. Photostatic copies of these documents have been furnished to the United Nations Cartographic Office, and to the Central Bureau of the International Map of the World on the Millionth Scale.



should be undertaken by the governments interested therein; (2) the Central Bureau of the International Map of the World on the Millionth Scale should add the preparation of the map to its existing functions; (3) a Permanent Council of four members should be constituted to assist the Central Bureau in the matter; and (4) the IMW should be used as the basis for the map of the Roman Empire. To date twelve sheets of the latter have been published, and two, covering Roman Libya, are in preparation.

Colonel Kirwan pointed out the need of reconsidering the status of the map of the Roman Empire in view of the proposed transfer of the Central Bureau to the United Nations, and raised the question of whether, in the event of the transfer, the Roman map should continue to be handled through the Central Bureau with its advisory Council, or should "revert fully to the International Geographical Union, where it started, and become the subject of a commission as it was after the Cambridge Congress of 1928". He also made it clear that such a decision "can hardly be made without the advice of the advisory Permanent Council".

Upon the suggestion of the Chairman of the IGU Commission, General Brown on 6 June 1952 sent copies of Colonel Kirwan's paper to the members of the Permanent Council, requesting their comments. These were being awaited when this report went to press.

(Signed) F. J. ALCOCK  
R. LI. BROWN  
Henri GAUSSEN  
Louis HURAULT  
Roland MILLER  
John K. WRIGHT, *Chairman*

*Final Recommendations of the Commission  
(adopted on 11 August 1952)*

*The Commission,*

*Having studied* the matters referred to it, and particularly that of transferring the Central Bureau, International Map of the World, 1:1,000,000 (IMW), to the United Nations, as set forth in its printed report submitted to this Congress,

*Having met* again on 11 August 1952, to discuss these questions at a meeting open to all members of the Congress,

*Understanding* that the Cartographic Office of the United Nations, acting as an international clearing house, would

continue the present services of the Central Bureau to all countries adhering thereto, Members and non-members of the United Nations alike,

*Understanding* that the United Nations would continue to facilitate the use of the IMW by those international organizations needing it, such as the International Map of the Roman Empire,

*Recommends* that the International Geographical Union:

(1) Do everything in its power to facilitate the transfer of the Central Bureau to the United Nations;

(2) Give its support to such a widening of the functions of the Central Bureau as would facilitate international agreement upon the measures necessary to keep the specifications and productions of the IMW continuously in line with modern international requirements as well as with the particular needs of individual countries;

(3) Set up a committee of cartographic experts to be available to advise the United Nations on behalf of the International Geographical Union as the need arises;

(4) Reaffirm the need for basic topographical mapping throughout the world, not merely as a proper basis for the IMW, but also as a first essential in economic and social development; and

(5) Urge the members of this Congress to keep these aspects of mapping before their governments.

VIII PAN AMERICAN CONSULTATION ON CARTOGRAPHY

Resolutions adopted by the Consultation on the subject of the International Map of the World on the Millionth Scale:

*Resolution 79.* The VIth Pan American Consultation on Cartography resolves ... that since the work on the International Map of the World at the scale of 1:1,000,000 is in progress, it is recommended that the member nations bear this in mind when planning cartographic work, and report on their progress at the next Consultation on Cartography.

*Resolution 183.* The VIth Pan American Consultation on Cartography resolves to suggest to the Pan American Institute of Geography and History ... to recommend to the United Nations a study of the specifications of the International Millionth Map of the World (IMW) for up-to-date revision in the interests of pertinent international agreements.

## ANNEX B

### Excerpts from replies received from experts

In accordance with the last paragraph of resolution 412 A II (XIII) of the Economic and Social Council, the Secretariat consulted a number of experts in the field. Excerpts from eight of the replies are included here, arranged in order of their receipt.

DR. JOHN K. WRIGHT, CHAIRMAN, COMMISSION ON THE INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE (19 November 1951)

At the International Geographical Congress at Lisbon in April 1949 a Commission on the International Map, 1:1,000,000 of the International Geographical Union was appointed

to make a study of problems relating to the map and to submit a report at the next congress, to be held in the United States in the summer of 1952.

This Commission has undertaken two principal investigations through letters of inquiry ... sent to the directors of the official surveying and cartographic establishments responsible for the production of the sheets of the International Map of the World (IMW) for the different countries:

I. A stock-taking in which the following information was requested:

"(1) What reproduction material, if any, on the scale of 1:1,000,000 is available in your country, and what are the edition dates of such maps?



" (2) What map sheets on this scale are in course of preparation by your Department?

" (3) Any suggestions that you may care to make regarding these maps of the world on the scale 1:1,000,000 at you think may be of interest and assistance to the Commission. "

he purpose [was] to secure the fundamental information led as a basis for further recommendations. Replies have been received from thirty-seven countries.

A request for comments on the following item in Commission's terms of references :

" In particular to ascertain how far the World Aeronautical Chart on the scale of 1:1,000,000 of the International Civil Aviation Organization may meet the purposes for which IMW is produced and vice versa, and whether any co-ordination between the two maps could be effected with advantage. "

In this connexion a memorandum stating tentative views of the Commission was sent to each of the officials as a basis for discussion. Replies have been received from sixteen countries ... a digest of the information and suggestions received through these inquiries [is being prepared] to send to the other members of the Commission as a basis for a preliminary report<sup>1</sup> to be submitted to the Executive Committee of the International Geographical Union before the end of December.

HERALD FITZGERALD, CHIEF TOPOGRAPHIC ENGINEER,  
UNITED STATES GEOLOGICAL SURVEY (20 November 1951)

This part of the world-wide programme—compiling and publishing the sheets of the United States portions of the IMW series—has been carried by the Geological Survey since 1909, when plans of the series were adopted by the International Geographical Congress. Progress has necessarily been slow due to the very limited appropriations made available for this work, and the extended interruptions when world wars and other situations required that ... all efforts be devoted to other work.

As the questions ... raised are rather general, they will be referred to several people who are most concerned with the IMW map series.

We ... will be glad to co-operate in studying present requirements and planning the appropriate future course for the United States sheets.

BRIGADIER-GENERAL H. S. RAZMARA, CHIEF, GEOGRAPHICAL  
SECTION OF THE GENERAL STAFF, IRANIAN ARMY (18 JANUARY 1952)

The original thought of [preparing] international maps of the world was initiated over sixty years ago, as a result of Dr. Penck's proposal to the First Geographical Official Congress at Bern. Unfortunately, the First and Second World Wars were great handicaps and slowed down the progress of this project. Now it is [a] great pleasure [to] hear the United Nations is seriously considering this project again.

Preparation of these maps, which was formerly being accomplished by the Central Bureau ... and is now being [co-ordinated] by the United Nations Cartographic Office, is another efficient step being taken by this organization ...

With regard to the characteristics—scales, projection system, sheet lines, legends, relief and bathymetric curves, colours, printing forms, coverage (framing, marginal data, etc.)—I thoroughly agree with the rules and regula-

tions approved at the London Conference in 1909, Paris Conference in 1913 and further London Commission in 1928 with the exception of two parts, regarding geographical proper names and methods of lettering of the maps, concerning which ... proposals<sup>2</sup> have already been submitted to the Economic and Social Council of the United Nations ... It is further noted that (a) with regard to the proper names ... it is advisable that geographical names all over the world be spelled and pronounced as they are by the natives of the locality concerned [and] (b) the method of writing has been described in the enclosed pamphlets in detail. These proposed alphabets serve sufficiently to provide for the Iranian names and pronunciations. But for the international transliteration it is, of course, obvious that more sounds are to be added to this alphabet. This can be accomplished in the United Nations Cartographic Office with the co-operation of the experts of the different nations ...

Reference to [Iranian Geographical Encyclopaedias] shows how the solution of the problems of pronunciation for the Iranian and the people of those countries having the Latin alphabet have been greatly facilitated ... Inscription of the names on the international map of the world, with the aid of the international alphabet, in addition to the propagation and use of these same maps, would better qualify them to be known as international maps. It is also worthy of note that these same alphabets can after being published be further adopted as a base for the international alphabet.

According to the contents of resolutions Nos. 8 and 9 of London and Paris ... certain rules were prescribed for the lettering of the names; ... if these rules are still executable when printing these maps, another plate with these international alphabets can also be made to supplement the previous prints.

According to the rules formerly adopted, it is necessary to write "International Map of the World—scale 1:1,000,000" on the top left corner of each sheet. Now this rule is not consistently applied; only the name of the continent and the scale are mentioned.

H. A. BAUMANN, DIRECTOR, TRIGONOMETRICAL SURVEY,  
UNION OF SOUTH AFRICA (26 FEBRUARY 1952)

[If] a one in one million map of the world is ever to be completed, one has to bear in mind the following facts :

(1) Except for the few great and wealthy nations, the mapping resources of most of the nations of the world are very limited. The mapping resources possessed by the small nations (and even some of the great ones) are strained to the limit keeping abreast of domestic mapping requirements.

(2) If, therefore, a one in [one] million map of the world is ever to become an accomplished fact, the work of producing [it] must, as far as possible, be integrated into the domestic mapping programmes of the member nations.

(3) In the World Aeronautical Chart series most nations of the world find common cause. The Union of South Africa and all members of the International Civil Aviation Organization are at present busy compiling, fair drawing, and printing, various sheets of this series.

(4) It therefore seems ... common sense that the projection, sheet lines, style and as many of the symbols as possible of the WAC series should be embodied in the international map of the world series.

<sup>2</sup> United Nations document E/2362, "International Co-operation on Cartography", annex IV (mimeographed).

<sup>1</sup> The report appears in annex A.

(5) By doing so, the mapping resources of member nations will be conserved, and a considerable economy and progress effected in the attainment of the object in view.

(6) Style, symbols, colouring and even the projection [are] very often a question of individual taste. On type of lettering, one colour, one projection is very often as good as any other. If that were not so, one would have cartographic uniformity throughout all the mapping agencies of the world [instead of] an exuberant diversity of mapping styles, which lend colour and interest to maps of different nations.

(7) Not doubt many arguments can be advanced in favour of continuing with the projection, sheet lines and specifications of the international map of the world; and as many arguments can be advanced against. These arguments are fruitless.

(8) The best means that might be adopted to further the completion of an international map of the world would be to adopt the sheet lines and projection of the WAC series and to apply as many of the symbols of the WAC series to an international map as can be advantageously used.

(9) If the above recommendation is put into effect it will enable the Union of South Africa to consider the production of an IMW series of maps covering the area of [its] responsibility in the WAC series.

(10) Before giving any suggestions regarding question (b) ... a decision should be reached regarding the matters raised above. Once it is known what is going to be produced, the question of method and what assistance the United Nations can give to national mapping agencies could be considered.

R. VERLAINE, INSTITUTE GÉOGRAPHIQUE MILITAIRE, BELGIUM (29 February 1952)

It should be borne in mind that renewal of work on this map depends on two basic requirements. (a) Few of the authorities concerned in financing or preparing the map will be able to take up the matter again unless the financial and technical efforts required to continue and finish the work are justified. In the first place, therefore, those who will use the map must emphasize the need for it. Its usefulness should be reaffirmed, and it should be adapted, possibly by changing certain details and some of the practical arrangements. (b) The organs carrying out the work (that is, the countries concerned) must have adequate means at their disposal and may possibly require assistance.

United Nations action will be effective only if the users, and particularly the geographers who are doing the main work on the map, first prove its usefulness and its present and future value.

Clearly, if the users support the map and revive general interest in it, United Nations action will have some chance of success. On the other hand, if those doing the work do not react favourably, the map will remain a dead letter and conditions will be against United Nations initiative.

That is why this note lays particular stress on the work to be done within the framework of the IGU Commission. That work must be as effective and extensive as possible. The means to this end are already familiar.

The question of the one-millionth map of the world appears to depend upon these basic considerations:

(1) It is the work of geographers—a special map with its own clearly defined features and standards.

(2) It was established in definite circumstances, but that was fifty years ago. Since then knowledge, techniques and so on have advanced. This raises the question whether the map's purpose, form and various details are all really up to date. Its specifications may have to be revised, bearing in mind the difficulties encountered, the present conditions, possible improvements, the use which may be made of work on other documents to the same scale, and other factors.

(3) It has been put aside for cartographic work of more urgency and more immediate practical use, designed to meet more pressing economic or other requirements. It has lost some of its adherents through the development of other projects (ICAO, for example). Owing to limitation on cartographic, technical and financial resources, it has in fact been postponed for other work regarded as more urgent.

(4) It has suffered from the repercussions of two wars and from their effects on the countries responsible for its preparation. Some countries have lost the necessary resources; others have gained them but have no responsibility for preparing it.

(5) The requirements have changed both in nature and in number.

As a result, the whole project has become seriously "devitalized". In fact there is no longer much enthusiasm for this particular map, since its usefulness and value are no longer sufficiently apparent. The first need is to regenerate the project and thereby arouse interest in carrying it out.

The first step in any serious work to promote the map must be to put new life into the project. This is basically the task of the International Geographical Union. Efforts should be directed towards: (a) emphasizing the general scientific and practical advantages of the map (both present and future); (b) reaffirming its usefulness; (c) studying a possible adaptation of its form and contents by amendments based on: (i) the changed requirements and scientific and other developments in all fields connected with the map; (ii) experience gained and difficulties encountered; (iii) the possibility of extending its practical usefulness; (iv) the possibility of co-ordinating its preparation with that of other cartographic work on the same scale, so as to provide further help towards its completion.

It may prove advisable to make the specifications more flexible (to emphasize the practical rather than the purely geographic and scientific aspects) and to revise arrangements, such as considering the possibility of producing the map in connexion with a project which is further advanced (for example, the ICAO World Aeronautical Chart). Among other things, this would mean reviewing the present division of work on its production [In addition, it may be advisable to interest] further groups of scientific, economic, and other workers in its production.

Since this map is the work of geographers, these first results could be obtained through the forthcoming geographical congress to be held at Washington in April 1952. The IGU Commission's report and the Washington discussions should reveal many concrete facts which will make it possible to see how the project stands, to overcome certain difficulties, and to create a favourable atmosphere for the production of the map—in a word, to achieve the aims set forth above.

However, the United Nations Cartographic Office should guide the Commission so that its first task would be to put new life into the project. The appropriate methods are known to all.

his part of the work must be carried out very seriously and carefully, because it is essential for the future. As far as possible purely academic discussions, which are apt to go on forever, should be avoided. That will in fact be the greatest contribution of the coming congress to the solution of the various questions referred to above.

It should be emphasized that this initial work by the cartographers is essential for the development of the project of the United Nations Cartographic Office. Before that office does anything towards implementation, the idea of a world map must be revived and a favourable atmosphere created in order to persuade those who will have to carry out the work that, although the map has more scientific and technical advantages, it will pay in the long run. These preliminary aims should be achieved at the next International Geographical Congress.

Once the desirability and usefulness of the map have been re-established and once the question of possible stages and of the technical rules governing its production has been settled, the Cartographic Office should turn to the second stage of the work, namely to find out and prepare the means and methods of producing the map.

The following approach might be adopted for this second phase of the work:

(1) On the basis of an investigation (to be carried out either at the International Geographical Congress) in the various countries (that is, by governmental action) a survey should be made of the general situation as regards the publication of the map and the facilities for carrying out the work. For the purpose of this survey, the minimum requirements are that the Office should: (a) find out the present situation as regards the map (the work already done, the stage reached in its production, the sheets brought up to date, etc., and comment on the execution of the project); (b) consider a new division of labour based on the wishes of the various States; (c) obtain information from each government regarding the work it can do on the map and its plans for the regions for which it is responsible; (d) collect any suggestions from governments regarding the production of the map and ask what steps they intend to take in order to speed up its production; (e) request governments with surplus mapping resources to specify the nature and extent of these and to state whether and on what terms they would be prepared to assist other less favoured countries which would like to participate in this joint international task; (f) among governments which state that they cannot undertake (or continue) work on the one millionth map, distinguish between: (i) those which possess adequate background material, asking them to state why they will not participate, and whether they would be prepared to hand over their background material; (ii) those which do not possess adequate background material, asking them to state why they cannot undertake or continue work on the map, and whether they would like to receive technical aid from other countries, or through the United Nations, and so on. This questionnaire, to be sent out by the United Nations, should be brought to the attention of the International Geographical Congress. It might perhaps be recommended to governments by the Council or the United Nations.

(2) A study of the replies to this questionnaire would provide very useful information of the concrete steps and general measures to be taken to enable the United Nations to play a useful part in the project and to speed up the completion of the map.

The United Nations Cartographic Office should then study all the individual cases and decide what steps should be taken and methods used to carry out the project. It

should, in fact, draw up a plan to include, in particular:

- (1) Recommendations by the Council;
- (2) An effort to encourage the governments and authorities concerned;
- (3) Studies of draft conventions between various parties, etc.;
- (4) Technical and financial assistance, direct or indirect;
- (5) Exchange of information;
- (6) General co-ordination;
- (7) Supervision of the production and of its uniformity (functions of the former Central Bureau);
- (8) Provision of guidance and useful information for the cartographers, to spare them unnecessary trouble and correspondence;
- (9) Provision for meeting promptly any needs that arise;
- (10) Dissemination of information on the stage reached in the work, and other activities.

In short, the plan would set on foot much joint international work, as set out in the 1949 report of the experts.<sup>2</sup> The Office would then turn to execution of the plan and would proceed to work on its various aspects through the regional organizations, the various large organizations and governments. This work would include (a) general recommendations to the Economic and Social Council, to the large organizations and to governments; (b) for countries with basic maps and adequate resources ... a little stimulus by (i) demonstrating the usefulness of the map (through the United Nations bulletin *World Cartography*); (ii) adopting recommendations urging countries to complete the map; and (iii) keeping close watch on the development of the work and encouraging countries according to their individual requirements, and so on.

For countries without mapping resources ... the work of the Office can be particularly useful (see the methods just mentioned under point 2 above). The lack of basic material and means and all the other needs which may arise will call for a series of measures varying according to the individual case and circumstances and depending upon the resources available at the time. Technical and financial problems will also arise. However, it seems premature to embark upon a detailed examination of all the aspects briefly referred to in this general note.

In conclusion, it may be stated that the problem must be taken up again systematically and that it would be inadequate and useless simply to transmit some sort of recommendation to the Economic and Social Council, or merely to give administrative encouragement. From the outset technical action will be needed.

(1) It seems essential to bring the matter before the International Geographical Congress, after very careful and detailed preparation. That is in fact the basic requirement.

(2) The next phase (the plan of action) will consist of finding out and shaping the best methods of carrying out the work.

(3) The actual execution of the programme will call for varied and appropriate work by the United Nations Cartographic Office. It would be premature to dwell further on this point now, because there are still too many uncertainties affecting the possibility of renewing and continuing work on this map.

<sup>2</sup> United Nations, *Modern Cartography: Base Maps for World Needs* (sales number: 1949.I.19).

GENERAL L. HURAUT, DIRECTOR, INSTITUT GÉOGRAPHIQUE NATIONAL, FRANCE (15 March 1952).

[It is understood] that the vast majority of the countries adhering to the Central Bureau of the International Map of the World on the Millionth Scale agree with the proposal to integrate it into the United Nations. The international map undoubtedly meets a world-wide need, and the project should at all costs be pursued. Changes could of course be made in its present technical features: but ... these should not be considerable, and the essential standards of the map as now published should remain unchanged. Any other approach would disturb and delay the completion of publication.

In any event, it would be difficult to solve all these problems by correspondence, and the Department of Social Affairs, as soon as it has received all the information collected through the investigations undertaken by General Brown and Dr. Wright, should call a meeting of experts to study the various problems in all their aspects and to reach to the most appropriate decisions.

[As to] what part the United Nations could play in the publication of the map, I stated in my letter of 29 December 1951 to Dr. Wright:

"One question which I believe to be important and which has not yet been raised is that of the financing of the international ... map of the world. Certain countries with reduced budgetary resources have been asked to publish a great many sheets, some of which involve serious difficulties because they require previous topographical research. Subsidies from the United Nations to the publishing agencies would certainly be highly desirable if we wish to avoid lengthy delays in the publication of these sheets."

MAJOR-GENERAL R. L. BROWN, DIRECTOR, ORDNANCE SURVEY, GREAT BRITAIN, AND PRESIDENT OF THE CENTRAL BUREAU (17 April 1952)

The United Nations Cartographic Office, should it take over the Central Bureau, will be faced with complicated and important problems, which have been aggravated by the war years and which it has not so far been possible to tackle with the resources at the disposal of the Bureau. In considering what the Cartographic Office should do to regenerate and carry forward the work of the Central Bureau it is necessary to look first at the functions of that Bureau as they were originally envisaged. These are primarily:

(1) To serve as a liaison between countries for the exchange of information;

(2) To assist those countries in the work of co-ordinating the publication of the maps in a standardized form. It should be noted that the Central Bureau was given no technical or administrative functions,

It seems important that the international nature of the project should be ... maintained. It is most necessary that all those nations which adhere to the [conventions on the international map] should continue to be served and it is particularly important that [among these the ones] which are not members of the United Nations Organization ... should be made to feel that they can continue to take part freely in the international mapping project after the Bureau has been transferred to the United Nations.

It is probable that the international character of the undertaking would be lost or prejudiced if the Cartographic Office were to undertake the mapping itself in some central establishment. It would seem therefore desirable that it should not enter this field but rather confine its efforts to co-ordinating those of the various adhering

countries. While the Cartographic Office should endeavour to stimulate activity in general on the initial production of sheets and on the revision of those in existence, it would probably be found advisable to allow nations to deal first with the sheets of which they themselves are most in need rather than to attempt to allot to them specific priorities.

If the Cartographic Office is to fulfil the original purposes of the Bureau it is suggested that it should endeavour to act on the following lines:

(1) Refrain from trying to impose any restrictions on individual countries that are not absolutely essential to the achievement of the main purposes of the map.

(2) While maintaining a standard specification, allow individual countries the greatest possible amount of freedom within it.

(3) Endeavour to secure the greatest amount of co-operation between countries.

(4) Make easy the free exchange of maps and material required for the project.

(5) Organize (rather than provide) assistance to those nations which have little or no mapping resources of their own.

(6) Endeavour to minimize the duplication of effort which may occur when the territories of more than one nation impinge on a single sheet of the international series.

(7) Maintain close touch with national mapping organizations, with other international mapping organizations such as the International Civil Aviation Organization and with all similar mapping projects in progress or planned.

If the project is to be advanced, it will be necessary to give a considerable amount of thought to the specification of the map. In doing so, it is necessary to consider the purposes for which the international map of the world was originally brought into being, whether these purposes need alteration or amplification, and the reasons why interest in the project has waned. It seems probable that the original specification was insufficiently flexible and that it has not kept pace with modern requirements. The present specification was laid down at a formal international conference in 1913 and it would seem therefore necessary in the early days after the transfer, to call a further formal meeting of all the countries interested in the project to decide upon the future specification and the future methods of working. As a preliminary to a general meeting on the subject it might be advisable to set up a committee to examine the question and draft a new specification.

It will be necessary to secure agreement on the answer to the following questions:

(1) Should the aim ... be limited to providing a topographic map of the world on the millionth scale?

(2) What purposes should the topographic map be designed to fulfil?

(3) Is the map required to serve as a base map on which special information can be shown for record or dissemination? If so, what weight should be given to this factor in the design?

(4) Should the collection and publication of special information, such as land use, be part of the project or not?

(5) Can the ICAO World Aeronautical Chart series meet either in whole or in part the purposes for which the international map was produced? Possibly it might meet the need in some regions for a considerable time, but could not do so at all in others.

(6) Is the present sheet layout and numbering system satisfactory?

Is the present polyconic projection adequate for the use?

From the interest shown by the International Geographical Union and by many nations since the war, it is evident that there is a desire for some form of international map of the world.

LIEUTENANT-GENERAL PHYA SALWIDHAN NIDHES, DIRECTOR, AERIAL MAPPING ORGANIZATION, THAILAND (17 April 1952)

Appropriate measures should be taken to enable the United Nations Cartographic Office to take over the functions of the Central Bureau of the International Map of the World on the Millionth Scale. Better co-operation and acceleration of the production of the map would result.

**INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE :**  
**TABLE LISTING INFORMATION RECEIVED IN 1953-1954**  
**ON SHEETS PUBLISHED OR IN PREPARATION**

*by*  
*Secretariat of the United Nations*

(The original table appeared as document E/CONF.18/A/L.1 under the title "Information received by the Cartographic Office on the Publication of the International Map of the World on the Millionth Scale")

**Table 1. Sheets Published or in Preparation**

Publishing agency	Sheets already published				Sheets in preparation	
	Original	Year	Revised	Year	New	Revised
Instituto Geográfico Militar, Buenos Aires, Argentina	SL 19 Comodoro Rivadavia	1952	SG 21 Corrientes	1952		
	SN 20 Isla de los Estados	1952	SH 21 Concordia	1952		
			SI 21 Buenos Aires	1952		
			SJ 21 Mar del Plata	1952		
Service cartographique du Congo belge, Belgian Congo	NB 32 Banzyville <sup>a</sup>	1942	SB 33 Léopoldville <sup>a</sup>	1942		
	SA 33 Banningville <sup>a</sup>	1942	SC 35 Elizabethville <sup>a</sup>	1942		
Geodetic Institute, Copenhagen, Denmark	NQ 27-28 Reykjavik	1954	NP 27-28 Hekla	1942		
			NO 32-33 { Denmark <sup>b</sup>	1953		
			NN 32-33 {			
Survey Department, El Giza, Egypt			NG 36 Aswan	1946		
Institut géographique national, Paris, France	NB 33 N'Ga oudéré <sup>a</sup>	1937	NM 31 Paris	1949		
			NK Pyrénées-Orientales	1949		
			NJ 31 Alger	1937		
			NI 30 Fès <sup>a</sup>	1954		
			NI 31 Alger-Laghout <sup>a</sup>	1948		
			NI 32 Tunis/Sfax <sup>a</sup>	1948		
			NH 29 Marrakech <sup>a</sup>	1946		
			NH 30 Colomb-Béchar <sup>a</sup>	1946		
			NH 32 Fort Flatters <sup>a</sup>	1948		
			NG 28 Cap Bojador <sup>a</sup>	1938		
			NG 29 Tindouf <sup>a</sup>	1948		
			NG 30 Erg Chech <sup>a</sup>	1938		
			NG 31 In Salah <sup>a</sup>	1951		
			NG 32 Fort Charlet <sup>a</sup>	1963		
			NF 28 Port Etienne <sup>a</sup>	1938		
			NF 29 Ouadane <sup>a</sup>	1942		
			NF 30 Taoudenni <sup>a</sup>	1937		
			NF 31 Fort Laperrine <sup>a</sup>	1954		
			NF 32 In Azaoua <sup>a</sup>	1948		
			NF 33 Djado <sup>a</sup>	1953		
			NF 34 Puits de Sarra <sup>a</sup>	1948		
			NE 28 St. Louis <sup>a</sup>	1940		
			NE 29 Tidjikja <sup>a</sup>	1946		
			NE 30 Tombouctou <sup>a</sup>	1938		
			NE 31 Kidal <sup>a</sup>	1944		
			NE 32 Agadès <sup>a</sup>	1940		
			NE 33 Bilma <sup>a</sup>	1938		
			NE 34 Faya <sup>a</sup>	1943		
			ND 28 Dakar <sup>a</sup>	1946		

Table 1. Sheets Published or in Preparation (continued)

Publishing agency	Sheets already published				Sheets in preparation	
	Original	Year	Revised	Year	New	Revised
Carte graphique nationale, France	NB 33 N'Gaoudéré <sup>a</sup>	1937	ND 29 Bamako <sup>a</sup> ND 30 Ouagadougou <sup>a</sup> ND 31 Niamey <sup>a</sup> ND 32 Zinder <sup>a</sup> NC 28 Conakry <sup>a</sup> NC 29 Kankan <sup>a</sup> NC 30 Bobo Dioulasso <sup>a</sup> NC 31 Parakou <sup>a</sup> NC 34 Fort Archambault <sup>a</sup> NB 29 Tabou <sup>a</sup> NB 30 Abidjan <sup>a</sup> NB 31 Porto Novo <sup>a</sup> NA 32 Libreville <sup>a</sup> SA 32 Port Gentil <sup>a</sup>	1943 1953 1946 1953 1948 1954 1953 1946 1954 1949 1938 1938 1953 1950		
Verlag, Berlin, Germany			NN 32 Hamburg <sup>c</sup> NN 33 Berlin <sup>c</sup> NM 32 München <sup>c</sup> NM 33 Wien <sup>c</sup>	1942 1943 1943 1935		
Korpus Angkatan Darat, Indonesia	SA 47 Padang SC 50 Singaradja	1942 1939			NB 46 Sabang/Nicobar Islands SA 48 Palembang SA 52 Ceram SB 52 Banda	
Survey, Dublin, Ireland			NM 29 Cork	1940		
Geografiske Oppmåling, Norway					NT 32-35 Spitzbergen	NR 34-35 Tromsø
Survey of Pakistan, Karachi, Pakistan					NI 42 NI 43 NG 46 NF 46	NH 41 NH 42 NH 43 NG 41 NG 42 NG 43 NG 45 NF 45
Allmänna Kartverk, Stockholm, Sweden			NO 34 Stockholm	1953		NO 33 Norrköping
Department of the Surveyor-General, Salisbury, Southern Rhodesia	SE 35-36 } Southern Rhodesia <sup>d</sup> SF 35-36 }	1943				SE 35-36 } SF 35-36 }
Department, Bangkok, Thailand			ND 47 Bangkok	1949		NE 48 NB 47 Songkhla
National Survey, Washington, United States	NL 10 Cascade Range NK 10 Mt. Shasta NK 17 Lake Erie NI 11 Los Angeles NI 17 Savannah NH 14 Austin NH 15 Mississippi Delta	1951 1949 1949 1952 1952 1951 1951	NK 16 Chicago NI 18 Hatteras		NJ 17 Blue Ridge NH 17 St. Augustine	

Source: Compiled from information sent by national cartographic agencies to the United Nations Cartographic Office from 30 September 1953 to 31 December 1954. This table is supplementary to the one published in the report for 1949-1951 of the Central Bureau of the International Map of the World on the Millionth Scale.

<sup>a</sup> Provisional edition.

<sup>b</sup> A combination of four sheets to show the whole of Denmark. Although these sheets have been made on the IMW model, they do not form part of the IMW series.

<sup>c</sup> Sheets sent by the Institut für Angewandte Geodäsie.

<sup>d</sup> A map on the scale 1:1,000,000, showing the whole of Southern Rhodesia, which does not form part of the IMW series.

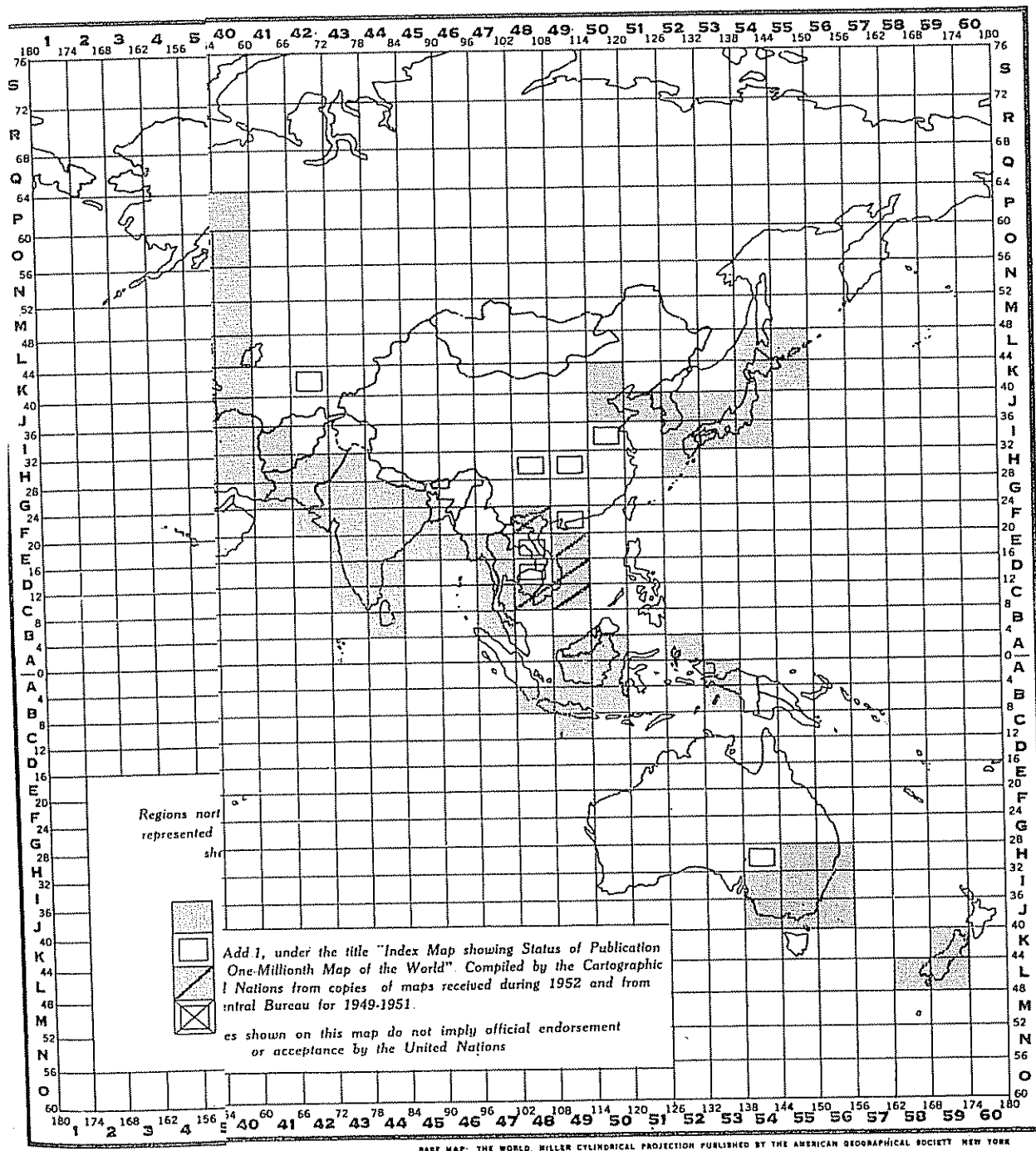
In addition, during 1953, the Cartographic Office received from the Conselho Nacional de Geografia of Brazil the twenty-four sheets listed below. Although these sheets which cover western and central Brazil follow the projection and general style of IMW, no indication was given as to their status *vis-à-vis* the IMW series.

NB 20 Roraima (1949)  
NA 19 Uaupés (1949)  
NA 20 Parima (1949)  
NA 21 Tumucumaque (1949)  
NA 22 Amapá (1950)  
SA 19 Ica (1948)  
SA 20 Manaus (1948)  
SA 21 Santarém (1950)

SA 22 Pará (1950)  
SB 18 Javari (1948)  
SB 19 Juruá (1948)  
SB 20 Purus (1948)  
SB 21 Tapajós (1949)  
SB 22 Araguaia (1950)  
SC 18 Contamana (1948)  
SC 19 Acre (1948)  
SC 20 Madeira (1948)  
SC 21 Juruena (1949)  
SC 22 Tocantins (1949)  
SD 20 Guaporé (?)  
SD 21 Cuiaba (1950)  
SD 22 Goiás (1950)  
SE 21 Corumbá (1947)  
SF 21 Rio Apa (1951)



# INTENDING STATUS OF PUBLICATION IN 1952'



MAP NO 479 (E)  
JANUARY 1957

## REPLIES FROM NATIONAL CARTOGRAPHIC AGENCIES

(The original text of this appeared as document E/CONF.18/A/L.2 under the title " Replies received from National Cartographic Agencies on IMW Specifications ")

Pursuant to resolution 476 B (XV) adopted by the Economic and Social Council on 6 April 1953 and following the taking over of the functions of the Central Bureau of the International Map of the World on the Millionth Scale (IMW) by the Cartographic Office of the United Nations, this Office addressed a circular letter to the national cartographic agencies of the countries adhering to the conventions on the International Map, requesting them, among other things, to submit their views regarding the specifications which govern the publication of the IMW sheets. The views expressed on this subject in the replies received during 1954 are summarized below.

### BELGIUM

The Institut géographique militaire, replying for Belgium, stated that its views were the same as those expressed by Mr. R. Verlaine (Institut géographique militaire, Belgium) and General L. Hurault (Director of the Institut géographique national, France) in the report<sup>1</sup> submitted by the Secretary-General to the Vth session of the Economic and Social Council.

In the opinion of the Institut géographique militaire, if map makers in this field are to be stimulated instead of discouraged, the publication of the sheets could be continued in order to avoid the necessity of making over sheets already published and, in particular, the sheet lines and the system of projection should not be modified.

The specifications should be changed only in such details as are considered necessary by experts on geography (concerning the facts to be represented) and by experts on cartography (concerning the choice of conventional signs, drawings, tints and the like).

The place name should be the official one used in the country represented and should respect the language (or languages) as well as the pronunciation.

The most rapid and efficient way to give impetus to this project would be to convene a meeting of expert geographers and cartographers of the various countries responsible for preparing and publishing the sheets of the international map.

### BELGIAN CONGO

The reply from the Belgian Congo consisted of observations from the Cartographic and Cadastral Office of the Ministry of Colonies of Belgium.

<sup>1</sup> See pages 32 to 34.

It pointed out that the preparation of maps on the millionth scale strictly conforming to the characteristics of the International Map of the World (IMW) and the World Aeronautical Chart (WAC) constituted an important and, above all, a costly task. On this subject it agreed with the opinion<sup>2</sup> expressed by Mr. H. A. Baumann, Director of the Trigonometrical Survey, Union of South Africa, and suggested that the United Nations consider consolidating the specifications of these two maps in such a way that the first might serve as a basis for the second.

### CANADA

The Surveys and Mapping Branch, Department of Mines and Technical Surveys, Canada, saw no possibility of further maps of this IMW series being published in that country, unless and until such time as the sheet lines were revised to conform to those of the International Civil Aviation Organization (ICAO) which are the same as Canada's national topographic series, and certain specifications and symbols were made to conform more nearly with the ICAO bases so that the IMW series could be produced without the extra effort of getting out an entirely new series of maps.

### DENMARK

The Geodetic Institute<sup>3</sup> emphasized that—if the IMW is to preserve its homogeneous character—changes in the specifications should be limited to those absolutely necessary, and advanced the following views:

The IMW and the WAC are to be used for different purposes: the one is geographical, and the other aeronautical. This fact carries with it different implications as to: (a) title and marginal notes; (b) graticule and graduation; (c) names and lettering; and (d) sea depth tints.

On the other hand, for practical reasons and for the sake of economy, the differences in content ought not to exceed those justified by these different purposes.

<sup>2</sup> See page 26 of this report.

<sup>3</sup> The views of this Institute concerning the existing specifications were expressed by their agreement with the conclusions noted in the appendix to "Inquiry regarding official points of view concerning the relationship of 1/M International Map of the World (IMW) and the ICAO World Aeronautical Chart (WAC)" in their letter of 25 October 1951 to Dr. Wright, Chairman of the Commission on the International Map of the World on the Millionth Scale.

poses. It should be possible to achieve unity in the specifications in the following domains :

#### *Projection*

A. For the World Aeronautical Chart ICAO 1:1,000,000 between 80 and 90 degrees of latitude, the polar stereographic projection has been fixed as standard (annex 4 to the Convention on International Civil Aviation).

B. Between 60 degrees south latitude and 60 degrees north latitude it would be desirable to obtain agreement concerning application of the same projection for the two maps.

#### *Sheet layout*

As the zones covered by the sheets for both maps extend over four degrees of latitude, and as the layout for the World Aeronautical Chart is merely recommended (annex 4, 2.3.1.), an agreement as to sheet layout should be obtained without difficulty.

#### *Contours*

The contour intervals of the IMW sheets are in principle 100 metres. If the principal curves in these maps were drawn at vertical intervals of 300 metres (in accordance with the normal contour intervals of the WAC maps), (annex 4, 2.9.1.1.) and if, in the WAC maps, the 150-metre contours allowed in special areas were changed into 100-metre curves in any area, unity concerning contour intervals would be obtained.

Sea contours are indicated only on IMW maps. They might be allowed on the WAC maps.

#### *Systems of colours for hypsometric tints*

It might be well for the WAC sheets to adopt the IMW systems as standard.

#### *Conventional signs*

In connexion with the revision of the IMW signs, the greatest possible conformity with the ICAO symbols should be borne in mind, even though the different purposes of the maps preclude complete uniformity in this domain.

#### FRANCE

The Institut géographique national replied that it could not yet offer concrete suggestions concerning the revision of the specifications governing the publication of the international map, but that its competent services expected to make a study of this important question during the summer of 1954. It remained of the opinion, however, that this map meets a world need and that the project should be continued, but that it would be necessary to observe the greatest prudence when revising the principal specifications.

#### IRELAND

The Ordnance Survey office of Ireland recalled that in July 1951 it had made some suggestions to Dr. J. K. Wright, Chairman of the Commission on

the International Map of the World, concerning the layout of sheets as affecting that country<sup>4</sup>. These comments had been made available to the Secretariat of the United Nations.

#### PAKISTAN

The Survey of Pakistan did not have any suggestion to amend the existing IMW specifications, but stated that it would abide by any decision that might be taken by the Cartographic Office of the United Nations in this connexion.

#### SOUTHERN RHODESIA

In view of the federation of Southern Rhodesia, Northern Rhodesia and Nyasaland, it was anticipated that the future mapping programme for the three territories would be undertaken by a central cartographical office, with its headquarters within the Federation, but as this question had not been settled, no views on the IMW specifications and no concrete suggestions for bringing them up to date could be given.

#### SUDAN

The Sudan Government's Survey Department considered that the International Map of the World on the Millionth Scale constituted a series of vital importance and usefulness. Its reply stated that efforts should be directed to the following ends: (a) gradually bringing the series closer to specification by providing a layered edition—which had already been started; and (b) proceeding with normal revision to bring old editions up to date by adding information from air survey compilations and other sources.

It agreed that in general the specifications and style of them IMW should be maintained, but would support minor modifications to bring them in line with modern practice. It had no specific modifications to recommend since the series as it stood fulfilled its requirement admirably. It therefore objected to any major alterations in specifications or any change in sheets, lines or style.

#### SWEDEN

The point of view of the Geographical Survey Office of Sweden was that no alterations of them IMW specifications were called for.

<sup>4</sup> The only adjustment recommended in regard to the International Map of the World concerned the fact that under the authorized layout this comparatively small country was shown on three separate sheets. All of the country except a small portion in the north-east and the south was included in NN 29 (Dublin). The northern eastern portion was included in NN 30 (Edinburgh) published by the British Ordnance Survey, and the portion in the south was shown on NM 29 (Cork) which had still to be published by the Ordnance Survey Office of Ireland.

The original layout for the ICAO World Aeronautical Chart followed the IMW lines, but in this case agreement was secured at the third session of the ICAO Map Division that the whole of Ireland would be shown on one sheet, to be known as 2172. The Ordnance Survey Office considered that it would be of advantage if something similar could be agreed to in regard to the IMW series.

## UNITED STATES OF AMERICA

The United States Geological Survey believed that, in general, the long-established specifications for the IMW map meet present-day requirements and are reasonably convenient for current compilation processes as well, but that one feature of the old specifications should perhaps be reopened for discussion at some opportune time—the uniform application of the metric system for hypsographic data. It recalled that this was a controversial matter some years ago, when many favoured the adoption of a flexible arrange-

ment whereby the general usage which prevailed in the respective national areas would determine whether the contour intervals were shown in metres or feet. As the Geological Survey's existing source data are uniformly expressed in feet, some interpolation is involved in compiling the IMW maps. This, plus the fact that the majority of the Survey's map users are much more conversant with the English system, suggested that the policy should be re-examined if and when the specifications were reviewed. A general discussion of the IMW specifications might therefore be of mutual interest.

## REPLIES FROM GOVERNMENTS

(The original text of this paper appeared as document E/CONF 18/A/L 3 under the title "Replies from Governments on the Question of the Adoption of a Standard Method of Writing Geographical Names on Maps")

In pursuance of resolution 476 A (XV) adopted by the Economic and Social Council on 6 April 1953, on the subject of international co-operation on cartography, the Secretary-General consulted with governments of the Member States of the United Nations and of certain non-member States on the question of the adoption of a standard method of writing geographical names on maps.

Up to 15 January 1955 replies had been received from twenty governments. The views expressed on the subject by these governments are summarized below.

### AUSTRALIA

The Government of Australia considered that the adoption of an international standard method of writing geographical names on maps was a desirable objective.

It was suggested that the most practical approach to the problem would be for the Cartographic Office of the United Nations to prepare a draft proposal thereon or for regional cartographic conferences to forward proposals for collation by the Cartographic Office into one draft proposal. This could then be circulated to governments and appropriate inter-governmental organizations for comment prior to final consideration by a special United Nations conference.

### BURMA

The reply from the Government of Burma also agreed that adopting a standard method of writing geographical names on maps would be suitable, provided this would apply only to maps issued after the adoption of such a method. It pointed out that making amendments and alterations on maps now in use, to conform to such a method, would be burdensome.

### CANADA

It was the opinion of the appropriate Canadian authorities that no practical solution has yet been offered to the problem of finding a universal standard method of spelling geographical names on maps.

Their reply stated that the Iranian proposal to adopt an international alphabet of phonetic equivalents does not by itself solve the problem, since there remains the further question of national variance in the form and pronunciation of foreign place names. Obvious examples are the French spelling of "Londres" for "London" and the English "Florence" for "Firenze".

The additional suggestion made in the Iranian memorandum that place names should be represented on all maps by phonetic symbols indicating the spelling and pronunciation used in their countries of origin would make learning to read maps tantamount to learning several new languages.

As an alternative, the following solution was offered as having the merit of simplicity.

(1) Since the end of the Second World War, the International Civil Aviation Organization has published a map of the world on the scale of 1:1,000,000.

(2) The five languages currently accepted as official languages by the United Nations are English, French, Spanish, Chinese and Russian.

(3) The maps of the International Civil Aviation Organization could be published, without the aeronautical signs and in one language, say English, with a translation in the four other languages on the back of each map. To explain symbols used, a legend could be printed in the five languages in the margin of the map.

### CEYLON

The Government of Ceylon expressed interest in being informed of any international arrangements concerning the writing of geographical place names on maps, and stated that it would endeavour to co-operate in this matter.

Three languages are spoken in Ceylon: English, Sinhalese and Tamil. At present all maps of Ceylon are published in English; some Sinhalese and Tamil editions are also issued. The script is different in each case. The place names used by the English speaking public occasionally differ from the Sinhalese and Tamil place names, mostly in the case of towns which came into prominence during the last two centuries. In more recent times, local place names have been transliterated into Roman characters, according to a government instruction, which has to some extent controlled the spelling of these names.

Ceylon has no national committee on geographical place names. The revenue officers deal with inquiries concerning the correct pronunciation and spelling of them. The village lists published in English, checked by field surveyors, are accepted as the authority for the spelling of village names.

Topographical maps on the scale of one inch to a mile have been made of the whole island. These maps contain a large number of place names and will be more than sufficient for world mapping purposes. The spelling of

is carefully checked during the examination of originals before being adopted by the Survey Department of Ceylon. The type face used for names of ages, plantations, hills and rivers generally follows style adopted on corresponding maps of the United Kingdom.

The procedure adopted by Ceylon is thus more or less in line with the general principles laid down by the United States Board on Geographic Names, or by the Permanent Committee on Geographical Names for British Official Use.

#### DENMARK

The Geodetic Institute of Denmark favoured the use of the Latin alphabet on all maps. It was suggested that, in cases where a country does not use this alphabet officially, the geographical names should be transcribed into—or possibly duplicated in—the Latin alphabet in accordance with fixed rules.

#### DOMINICAN REPUBLIC

The Instituto Geográfico Militar of the Dominican Republic follows the recommendations of the Pan American Institute of Geography and History, in accordance with article 3 of Law 2136 of 22 October 1939, which stipulated that "fundamental geographical and cartographical work should be in conformity with the agreements reached at international scientific congresses approved by the Republic and especially with the specifications of the Pan American Institute of Geography and History".

#### EGYPT

The Government of Egypt regretted its inability to furnish information of an international character, as the maps of Egypt are published in Arabic.

Regarding maps published in the English language, the Egyptian Government was prepared to accept the decisions to be taken by the Economic and Social Council, following consultations with governments publishing maps in other languages and agreement on the unification of writing methods.

#### ETHIOPIA

The Government of Ethiopia favoured the adoption of a standard method of writing geographical names on maps, but withheld comments on the question until the Secretary-General could make available documents clarifying certain points.

#### FRANCE

A study on the adoption of a standard method of writing geographical names on maps was submitted to France. Commenting on the recent favourable attitude in this direction, the study pointed out that the International Civil Aviation Organization, although it did not give its member countries publishing nautical maps any definite instructions about the adoption of such a method, has agreed that the original

spelling of the place names in each country shown on its maps should be used not only for aerodromes but also for the rest of the map.

The study also mentioned that, after the meeting of experts at Bukavu, Belgian Congo, from 11 to 14 November 1953, the Scientific Council for Africa South of the Sahara made the following statement:

"The Committee agrees that toponymy is the concern of the Government of each Territory. For general maps intended for use in countries other than the one in which they are published, the spelling of names should follow the rules adopted in the countries shown on the maps", and further, "if a name is translated into another language, the translation should be in brackets to show that it is a secondary name. Example: Cape Town (Le Cap)."

Furthermore, international military institutions, whose members have to consult general maps covering many countries, recommend the prompt adoption of such a method.

The Institut géographique national, which publishes general world maps, was asked for its opinion; some of its views are given below.

Agreement should be concluded for the active exchange of maps between cartographical institutes for their mutual documentation.

All maps come under this study, except those intended for a limited or local public (large-scale maps) or for a public confined within national boundaries (popular maps on a very small scale or atlas maps), although, in connexion with the study of atlases, the question arises whether it would not be advisable to accustom children to the original spelling.

#### *Toponyms<sup>1</sup> used on maps*

Toponyms may be divided into: (a) place names—proper names which suffice to designate a geographical place or area, for example: Paris; and (b) geographical expressions—groups of words comprising a geographical term<sup>2</sup> and a name,<sup>3</sup> which may or may not be connected by a preposition; definite articles may precede the geographical term or the name, for example: cap de la Hague.

#### *Source of foreign toponyms*

As a general rule the source of toponyms should be the original documents published by the national map institute of the sovereign State responsible for the territory concerned.

#### *Method of writing foreign place names*

*Place names in Latin characters.* This type of toponym should not cause any difficulty, as standardization

<sup>1</sup> "Toponym" means a word or group of words identifying a geographical place or area.

<sup>2</sup> A geographical term is a common noun indicating the type of geographical place or area, for example: basin, cape.

<sup>3</sup> A name is a proper noun, a common noun or an adjective which, when accompanying a geographical term, designates a geographical place or area, for example: bassin Freycinet, ile aux Moines, cap Rocheux.

of spelling will result if the original spelling is retained. However, the publishing country should give in brackets the form of the name most widely used within its own borders, when this form is markedly different from the foreign original, for example: s'Gravenhage (The Hague); Firenze (Florence).

For alphabets in which some letters bear diacritical marks, a table indicating the pronunciation in the language of the publishing country should be given in the margin of the map, as shown in the following example:

Romanian	Czech	Polish	Hungarian	French pronunciation
ă			ő	eu
ș	š	Sz	S	ch

*Place names in Arabic characters.* Very few maps are published in Arabic; some do exist, but most maps of the Arabic-speaking countries are published by countries which use Latin characters.

It was proposed that for North Africa, Syria and Lebanon, the French transliteration system should be internationally recognized and adopted. For Libya, either the English or the French transliteration system might be used, preferably the latter, since it is more widely known in Africa, the Arabic-speaking countries and Fezzan. The English system, on the other hand, might be adopted for the other Arabic-speaking countries, such as Egypt, Arabia and Iraq, for example: Taroudant, Cairo (Le Caire).

*Place names in Cyrillic and related characters.* For the countries in question (Union of Soviet Socialist Republics, Bulgaria), there can be no standardization until a common system of transliteration is adopted. In this case, the system proposed by the Permanent Committee on Geographical Names for British Official Use might be used, with a table in the margin of the map giving the transliteration into the language of the publishing country, as the following example would indicate.

Permanent Committee on Geographical Names	French phonetic transliteration
Zh	j
Sh	ch

The name generally used in the language of the publishing country may of course be added after the local names written according to the Permanent Committee's system, for example: Moskva (Moscow); Tbilisi (Tiflis).

*Place names in Greek characters.* The new system of transliteration of Greek characters worked out by the Permanent Committee seems to be quite reliable. The Institut géographique national is considering using it under the same conditions as for the transliteration of Cyrillic characters.

*Place names taken from Chinese or other characters.* There are maps of varied origin, in Latin characters, of China, Japan, Korea, Indo-China, Thailand and other Far Eastern countries. In the absence of a

common system of transliteration, the publishing institutes might reach an agreement on the maps to be used in reference. For Indo-China, the French road map on the scale of 1:400,000 and the chart of the International Civil Aviation Organization on the scale of 1:1,000,000 are proposed. For the other Far Eastern countries the maps published by the English-speaking countries should be used.

If there is no likelihood of this proposal being adopted, the Institut géographique national would agree to a common system of transliteration, since, although the French missions sent to that area from 1900 to 1904 returned with a partial system of transliteration, to be found in particular on the SGA maps of Asia on the scale of 1:1,000,000, the English transliteration system, being more widely used for most of the territories on maps of the Far East, would appear to be the one to be recommended.

#### *Method of writing foreign geographical expressions*

*Geographical expressions in Latin characters.* Geographical expressions present greater difficulties than place names, as such expressions often comprise a proper noun and a common noun, which may or may not be connected by a preposition. However, a standard method of writing geographical names could logically be based on the original expression. For instance, one might write: Golfo di Napoli, Cordillera Cantábrica, and the like. A glossary in the margin of the map would give a translation of the common nouns and adjectives, for example:

Norwegian	Dutch	French
bukt	baai	baie
sfo, -a, -e	groot	grand, -e

*Geographical expressions in Cyrillic characters.* It is obvious that a standard transliteration of Cyrillic characters must be based on a common system, as in the case of place names.

The translation of common nouns into the language of each publishing country, possibly with the proper case if the noun is declined, would result only in divergencies. For example, the expression in Cyrillic, ВЕРХОЯНСКИЙ ХРЕБЕТ, becomes "monts de Verkhoiänsk" in French, "Werchojanisches Gebirge" in German, or "Monti di Verkoiansk" in Italian; but if it were transliterated according to the system of the Permanent Committee on Geographical Names, the expression would be written uniformly "Verkhoyanskiy Khrebet" in all three languages.

A corollary of this method would be the addition of a glossary in the margin of the map giving the translation of the common nouns used, for example:

Russian	Abbreviation	French translation
Khrebet	Khr	chaîne de montagnes
Ostrov	O	île

There should also be a table indicating the corresponding phonetic transcription, as for the place names



*Geographical expressions in Arabic, Chinese or other characters.* As these expressions have already been transliterated into Latin characters in the map-publishing countries, it would be advisable to retain the spelling of expressions comprising "local words" and place names already on the maps, as in: Jbel Sarho, mmada du Dra, Dasht-I-Kavir, High Atlas. Some of the more important common nouns might, however, be translated, as in: Tibetan Plateau, Dahna Desert. The same system might be applied to the names of seas and geographical expressions common to several countries, for example: Aral Sea, Sea of Japan, Chain of the Andes.

The study concluded with the statement that the problems raised by the writing of geographical names on maps would obviously have to be considered again at international conferences such as those proposed by a number of persons interested in the international map of the world on the millionth scale.

The Institut géographique national expressed its willingness to provide the Economic and Social Commission with any additional information which might be required.

#### INDIA

The Government of India considered that the preparation of a single special alphabet for writing the names of all countries was most desirable.

All countries produce maps of their territories for their own use in their respective national languages; of course, all place names on maps of India published in that country will be written in Hindi. It will therefore be necessary for all countries to prepare a system of transliterating all letters of their languages into the Roman alphabet on a phonetic basis.

In India the Hunterian system is used, whereby every sound in the local language is uniformly represented by a certain letter in the Roman alphabet. This system could be modified and expanded to include the alphabets of all other countries, in order to produce a correct phonetic spelling of all geographical names. Once the names were written in accordance with this special alphabet, a fairly comprehensive key to pronunciation would have to be entered on every international map, giving phonetic equivalents in the language commonly used in the region concerned.

#### ISRAEL

Israel submitted in reply the following observations: Dr. D. H. K. Amiram, Director, Department of Geography, Hebrew University, Jerusalem, on the question of a standard method of writing geographical names on maps.

The proposal that each geographic name should be written in accordance with the local version should be supported. However, a limited number of names could still be written in the conventional way. Thus, we would write "Jerusalem", not "Yerucalayim". Any examples from other countries could be found. It would perhaps be advisable in each case to add the local version between brackets. This question should

be settled by a cartographic conference, which would also have to list the names to be written according to conventional usage.

Assuming that the most common method of writing geographical names on maps is the one known as RGS II, which is especially well adapted to the English-speaking public, the proposal<sup>4</sup> made by Brigadier-General Hussein Ali Razmara could be adopted with certain reservations:

- (1) The letter "W" should be added, because of the pronunciation it has for example in German;
- (2) The letter "X" should be retained in its original pronunciation, as in "Alexandria";
- (3) Instead of placing an apostrophe before a letter and on a line above it, placing two apostrophes after the letter would avoid confusing "j" or "i" with "y".

Accordingly, the method used in the following example is suggested:

Signs	French pronunciation	English pronunciation
g"		George
j"	jardin	
x"		Kh
s"		shoe

#### JORDAN

Several attempts have been made to devise methods of transliterating Arabic names into other languages. A standard method of transliterating them into English was established by the Royal Geographical Society of London. Prior to 1948, the Government of Palestine attempted to standardize and transliterate the non-European sounds of the Arabic language, using, for example, h for ح, gh for غ, ' for الهمزة. The French map makers also had a scheme for the transliteration of Arabic names, which differed from that of the English. For example, the sound ح was rendered on French maps by dj, whereas on English maps it figured as j.

It was suggested that the linguistic academies in Cairo and Damascus, together with the Royal Geographical Society of London, should be consulted in any discussion on the standardization of maps for the Arab world.

#### LIECHIENSTEIN

The question of adopting a standard method of writing geographical names on maps does not arise for the Principality.

#### LIBYA

The Government of Libya approved of the adoption of a standard method of writing geographical names on maps.

#### NORWAY

The Government of Norway was of the opinion that, for countries using the Latin alphabet, the general

<sup>4</sup> United Nations document E/2362, "International Co-operation on Cartography", annex IV, "A Proposal regarding Geographical Names" (mimeographed).



principle applied in Norwegian publications, that is, to use the local form of geographical names to the greatest extent possible, would best further an international standard method of writing names on maps. The exceptions mentioned below would have to be considered separately.

For instance, if the country in question has a different alphabet, Norwegian publications adopt the form as used in one of the widely used world languages or use Norwegian letters to approximate the name as pronounced in the country concerned.

In some cases entirely Norwegian forms of long standing, usually modernized in accordance with the latest spelling, are employed.

Norwegian rules with regard to the plural form are generally applied.

#### PAKISTAN

The Government of Pakistan agreed with the proposals<sup>5</sup> made by the Geographical Section of the General Staff of the Iranian Army, but was of the opinion that it would be desirable for all countries to adopt a uniform spelling for geographical names, conforming to that established by usage in the country concerned, and that Roman lettering should continue to be used for all international maps on the millionth scale. All countries should be consulted prior to the compilation of a single special alphabet with a view to writing and pronouncing geographical names uniformly, so that all essential sounds peculiar to the languages of individual countries may be included.

The Government of Pakistan has been using Roman lettering on geographical maps. The spellings adopted for the area falling in India and Pakistan are those given in the *Imperial Gazetteer of India*, published by the Clarendon Press, Oxford. For other countries bordering Pakistan, the spellings are taken from the lists published by the Permanent Committee on Geographical Names for British Official Use. For the transliteration of names which cannot be dealt with by means of these publications, a special key is used.

#### PHILIPPINES

The Philippine Committee on Geographical Names, created under Executive Order No. 474, 25 August 1951, has final discretion on the establishment of a uniform usage in regard to geographic nomenclature and orthography on maps and charts issued by the Philippine Government.

The International Hydrographic Bureau, in November 1948, published a draft proposal for a uniform system of placing geographic names on nautical charts and documents of maritime countries, which might be similarly applied to maps mentioned by the Secretary-General of the United Nations. The Philippine Bureau of Coast and Geodetic Survey agrees on general principles with this draft proposal, although, since it publishes only a few charts and maps of foreign countries, it is not greatly affected by a standardized method of writing place names. In case of doubt, the English way of spelling foreign names is preferred.

<sup>5</sup> See footnote 4.

With regard to local geographic names, the Roman alphabet is used, with a more or less consistent orthography based on local dialect, Spanish, or English, which in each particular instance has been established by law, administrative order or common usage.

#### PORTUGAL

In principle, the Government of Portugal would find advantageous the adoption of a uniform method of transcribing geographic names on maps, but would expect to be informed in due course of the basis upon which the Economic and Social Council proposes to apply such a method.

#### SWEDEN

The reply from Sweden stated that it would be of great value not only for cartographical reasons but also for the sake of better understanding between different language groups if an international standard could be evolved and generally acknowledged. Such a standard would be of special importance for maps which are used internationally, particularly small-scale survey maps. The question is of limited significance for the large-scale economic and topographical maps as well as for the survey maps and general maps published by the Swedish Survey Office, which include only small portions of foreign countries.

The Survey Office has the task of issuing four sheets of the international map of the world on the millionth scale. According to a convention adopted at an international conference held in Paris in 1913, the forms of names on this map are to correspond to the names used in each country.

It would seem desirable that the standardization now proposed should be along the same lines. If, in order to establish such a standard, information on the correct forms of Swedish geographical names is required, such material is easily accessible in the publications of the Central Office of Statistics or from maps published by the Survey Office. Place names of international interest can be obtained from the general map on the millionth scale.

#### UNITED STATES OF AMERICA

The toponymic and linguistic aspects of this question, which are primary, should be considered prior to discussion of the cartographic aspects.

A conference on toponymic and linguistic aspects of international uniformity in the writing of geographic names could be productive if approached with the understanding that a considerable degree of international uniformity in writing geographic names is feasible and desirable, but that complete international uniformity is not feasible.

It would be desirable for these two aspects to be considered by an international conference, held under appropriate United Nations auspices, prior to the consideration of this matter at any of the regional cartographic conferences that are contemplated.

Uniformity in the writing of geographic names in the Roman alphabet, by countries using the Roman alphabet, is feasible except for the names of countries of some natural features common to two or more countries. It should be noted that in 1952 steps were taken to accomplish such uniformity, at the IIIrd Consultation on Geography of the Pan American Institute of Geography and History, the XVIIth International Geographical Congress, and the IVth International Congress of the Onomastic Sciences.

On the other hand, complete international uniformity, involving the writing of all the geographic names of all countries in the writing systems of all their countries, is precluded by the occurrence of

significant sounds in some languages that do not occur in others, and by the wide variety of symbols used to denote the same or similar sounds. A much greater degree of uniformity than now exists is possible, however, and is desirable.

The United States Government would be willing to co-operate in drafting a general framework for a programme looking towards maximum international uniformity in the writing of geographic names, for consideration by the United Nations Economic and Social Council, or by an international conference called by the Council for that purpose, or in drafting an agenda for such a conference.

# ASSISTANCE PROVIDED BY THE UNITED NATIONS TECHNICAL ASSISTANCE ADMINISTRATION

by

*Secretariat of the United Nations*

(The original text of this paper appeared as document E/CONF.18/A/L.4 under the title "Notes on Assistance provided by the United Nations Technical Assistance Administration in Cartography and Allied Fields")

The United Nations Technical Assistance Administration regards as important the opportunity to provide means of assistance to governments in acquiring the basic tools of economic development. Among these is assistance in survey with a view to the discovery and exploitation of natural resources. Several governments have requested the services of experts for direct assistance in developing or co-ordinating cartographic organizations or demonstrating cartographic techniques with modern equipment, some of which has been provided to the governments concerned. In other cases a cartographic record is kept by the national organ concerned as part of the task of geological or geophysical survey in which the expert is assisting, or as a concomitant of exploitation of mineral or water resources.

Eight countries in Asia, two in Latin America, one in Africa and one in Europe have requested expert assistance in general survey including cartography; thirty-three fellowships have been awarded, and some important modern surveying equipment has been provided.

Upon the request of governments, the Technical Assistance Administration is ready to make available assistance in branches of cartography, including geodesy, topographic mapping, photogrammetry, map reproduction and organization of cartographic services.

## TECHNICAL ASSISTANCE IN CARTOGRAPHY AND ALLIED FIELDS

### *Africa*

#### *Libya*

A Canadian expert was sent to Libya in January 1953, at the request of the Government, to work in co-operation with a United States Foreign Operations Administration water survey team, then drilling in Tripolitania.

The United Nations expert examined the drill cores for minerals of economic value and identified rock formations to assist in the survey of the area's water resources. At the same time he undertook an independent geological and tectonic survey of the Garian and Jefren areas, with a view to producing a geological map and correlating the drilling results with the

surface outcrops, since this picture was essential to an understanding of the water problems of the area. The expert completed his assignment in March 1954.

### *Asia and the Far East*

#### *Afghanistan*

A topographic expert from the Netherlands served as a United Nations expert in topography in Afghanistan from July 1952 to August 1954. Originally, he was attached to an oil resources development project in which the Government was engaged, but after its cessation at the end of 1952, he made preliminary topographical surveys for a water resources development project. He assisted in the preparation of plans for the systematic exploration of water resources in selected areas, mainly in the general region of Mazar-i-Sharif, and was also called upon to train students at the Afghanistan Institute of Technology in basic survey techniques.

#### *China: Taiwan*

As part of a comprehensive programme of exploration for oil in Taiwan, a petroleum geologist from Australia, made available by the United Nations, is advising on completion of geological maps of potential oil-bearing areas in the country.

#### *India*

A photogrammetry project combined the three main types of assistance available under the Expanded Programme of Technical Assistance: in 1953 it provided photogrammetric equipment (plotting machine and aerial camera) to the value of \$50,000 for the survey of India at Dehra Dun; in 1954 it made available two fellowships in photogrammetry for observation and training with Swiss manufacturers and later at the International Training Centre for Aerial Survey in the Netherlands, and sent a Norwegian photogrammetry expert to train officers of the Survey of India in the use of the equipment. The Department of the Survey of India is responsible for the regular mapping programme of the country, including the production of large-scale maps for engineering development projects. The introduction of photogrammetry will enable the Survey to produce maps with the latest techniques.

expert has trained plotters and surveyors using aerial photographs pending the installation of the aerial camera: one of the training projects covered a large area in Rajasthan. A second aerial camera is being supplied under the United States bilateral aid programme.

In 1952, the United Nations provided the Government of India with the services of a hydrographic expert from the Netherlands for two years to make a survey of selected ports on the Bombay coast and to train local personnel in hydrographic survey methods as part of its fifteen-year programme for minor port development. The combined training programme and hydrographic survey has given engineers in training practical experience in triangulation and survey techniques, at the same time producing important survey material, including maps of limited areas, such as rivers and harbours in the state of Bombay.

The expert trained two teams of surveyors, using motor vessels built in India. During his absence a survey and analysis was successfully initiated and completed by trainees, many of whom had had no experience whatever in hydrography previous to his training.

#### *Iran*

A cartographic expert from France was in Iran from October 1952 to December 1953, to assist the Iran Oil Company (which is a subsidiary of the seven-year plan organization and distinct from the National Iranian Oil Company) to look for new sources of oil. He aided the Government to establish a national cartographic centre, designed to co-ordinate the cartographic activities of various governmental departments, and to provide a central source of cartographic information.

Following this, a request was made for a cartographic expert to advise the Government on the policy and technical aspects of mapping Iran, particularly the aerial survey which was being planned. Accordingly, an expert from the Netherlands went to Iran for this purpose in October to December 1954.

#### *Laos*

The Government of Laos requested the services of an expert topographer to assist in the organization of the topographic service set up in April 1954, and also to train surveyors and cartographers to staff the service.

#### *Federation of Malaya*

In 1953 the Technical Assistance Administration provided the services of a Canadian geophysicist, who made a two-month preliminary survey of areas in Malaya which appeared to merit close study by aeromagnetic survey; in 1954 it made available the services of two experts from a French firm, who made geophysical tests and advised the Government on the use of geophysical methods and equipment. The team, which used seismic, electric and magnetic methods, obtained valuable information on delimitation of geological strata.

After having completed a three-month contract with the Technical Assistance Administration, the two experts continued working for three months directly for the Government of Malaya.

#### *Nepal*

The first over-all geological survey of Nepal was undertaken by the Government with the assistance of a United Nations geologist from Switzerland, who carried out extensive field journeys through central and western Nepal in 1954, in which year he was assisted by a Swiss petrologist in training local geologists and mining engineers to use modern microscopic methods of examining rock samples. Some two-thirds of the country had been surveyed by 1955. The completion of the geological map of the country may require another two or three years.

#### *Pakistan*

The increase in Karachi's population from 300,000 in 1940 to over one million in 1951, as well as three consecutive years of drought, have aggravated the unfavourable situation of the city and its environs with regard to water supply.

On the basis of a preliminary survey made in March 1953 by a United Nations expert from the Netherlands, a firm of French geophysicists, first engaged by the Technical Assistance Administration at the request of the Government of Pakistan, and later working under direct contract to that Government, carried out a hydrological survey by electrical prospecting in the regions of Karachi and Hyderabad.

A total of 592 electrical soundings were made over a total area of approximately 400 square miles. Some of the data obtained were presented in the form of eight geological and resistivity maps of the areas concerned in scales ranging from three inches to one mile to one inch to four miles.

#### *Europe*

##### *Greece*

In 1954 an expert advised the Greek Government on the systematic development of the country's mineral resources. In particular, he assisted in setting up a national research centre to co-ordinate the functions of existing institutions which deal with this problem, such as the Institute for Geology and Sub-Soil Research, the Bureau of Mines, the phototopographic services and research laboratories. The Government also requested the services of a civil engineer expert in aerial photography to act as general adviser to the Greek phototopographic services, and various items of equipment were furnished to the Greek Government.

##### *Latin America*

A request for assistance in carrying out an aerial survey was received in 1953 from British Guiana, but could not be implemented because of lack of funds. Another request, from Uruguay, for assistance in creating a regional training centre in cartography in Montevideo was under consideration.<sup>2</sup>

<sup>2</sup> The centre started the training course in 1956.

<sup>1</sup> This request was later implemented.

FELLOWSHIPS AND SCHOLARSHIPS IN  
CARTOGRAPHY AND ALLIED FIELDS

Thirty-three fellowships or scholarships were awarded  
by the United Nations in cartography and related

fields from 1949 to 1954. Seven fellows came from  
Asia, eleven from Latin America, and fifteen from  
Europe, the Middle East and Africa.

Table 2. Technical Assistance Fellowships and Scholarships  
awarded from 1949 to 1954 <sup>a</sup>

<i>Recipient country</i>	<i>Cartographic or allied field of study</i>	<i>Host country</i>
1949 :		
Colombia .....	Photogrammetry	United States
Costa Rica .....	Photogrammetry	United States
1951 :		
Denmark .....	Photogrammetry	Canada
Greece .....	Photogrammetry and cartography	Netherlands
Iran .....	Photogrammetry	Netherlands
Israel .....	Photogrammetry	United States
Venezuela .....	Photogrammetry	Netherlands
Venezuela .....	Photogeology	Netherlands
1952 :		
Ecuador .....	Photogrammetry	Mexico
Ecuador .....	Photogrammetry and cartography	Mexico
Uruguay .....	Photogrammetry	Netherlands
1953 :		
Belgian Congo .....	Photogrammetry	Netherlands
Jordan .....	Photogrammetry	United Kingdom
Iran .....	Photosurvey	Netherlands
Japan .....	Photogrammetry <sup>b</sup>	Netherlands
Korea .....	Geological survey	United Kingdom
Liberia .....	Photogeology <sup>b</sup>	Netherlands
Liberia .....	Photogrammetry	Netherlands
Pakistan .....	Cartography	United Kingdom
1954 :		
Bolivia .....	Photogrammetry	Netherlands
Bolivia .....	Photogeology	Netherlands
Ecuador .....	Hydrographic and topographic surveys	Mexico
India .....	Photogrammetry <sup>b</sup>	Switzerland and Netherlands
Iran .....	Photosurvey	Netherlands
Iraq .....	Geological survey (ground water)	Germany
Liberia .....	Photogrammetry	Netherlands
Pakistan .....	Photogrammetry	Netherlands
British East Africa .....	Geological survey (mining)	Union of South Africa
Uruguay .....	Photogrammetry	Netherlands
Yugoslavia .....	Oil geology	France

<sup>a</sup> In 1950 no awards were made.

<sup>b</sup> Two awards.

# MEASUREMENT OF STANDARD BASE LINES WITH THE VÄISÄLÄ COMPARATOR

by

Dr. T. J. Kukkamäki  
Finnish Geodetic Institute

(The original text of this paper, submitted by the Delegation of Finland,  
appeared as document E/CONF.18/A/L 5)

Some systematic errors may occur when invar wires or tapes are to be standardized in indoor laboratories with short comparators. The handling of the wires and circumstances at the comparator are different from the handling and circumstances in field measurements. To avoid this source of error, the late Dr. Ilmari Bonsdorff, then Director of the Finnish Geodetic Institute, suggested to the International Association of Geodesy use of standard base lines for the standardizing of the invar wires. The Association passed a resolution in 1933, in which it recommended the establishment of standard base lines of 500 to 1,000 metre length in different countries.

In this way it is possible to get a uniform scale for triangulation in a region where base lines have been measured with wires standardized on one and the same standard base line. In the determination of the absolute length of a standard base line there are, however, systematic errors to be suspected in case the measurement depends on invar wires standardized in an indoor comparator, as is customary. To avoid this error, the Finnish Geodetic Institute has used the Väisälä comparator, measuring the length of its standard base line directly with light interference without a transmission of wires.

Dr. Y. Väisälä developed his method over thirty years ago. He was at that time able to make an experimental measurement to the distance of 80 metres.<sup>1</sup> Later he completed his equipment and measured to a distance of 192 metres,<sup>2</sup> and even to 384 metres. The Finnish Geodetic Institute purchased a Väisälä comparator and used it at first for standardizing wires, but later the entire 864-metre length of the Finnish standard base line at Nummela was measured by Drs. T. Honkasalo and T. J. Kukkamäki.<sup>3</sup>

The observation of the full length of this base line was possible only under favourable weather conditions, that is, with overcast sky and with temperature distribution as even as possible, but the distance of 432 metres, and shorter distances than this, are not too sensitive to the weather. An accuracy of -0.05 millimetres, that is, 1:17,000,000 was reached.

Encouraged by this successful experience, the Finnish Geodetic Institute proposed to the International Association of Geodesy in 1951 a recommendation for the establishment of standard base lines and the measurement of them with the Väisälä comparator. The Association adopted the following resolution:

"The International Association of Geodesy, considering the high accuracy obtained in the measurement of a standard base line in Finland with a light-interference apparatus, recommends that such bases be measured by a similar method in different countries by the interested organizations and asks the Bureau of the Association to facilitate necessary arrangements so that such bases could be used, if desired, by neighbouring countries, to compare the results obtained by this process with those obtained by wires or tapes compared to the standards of the International Bureau of Weights and Measures."

In the same year the Finnish Geodetic Institute offered co-operation in the use of Väisälä comparators to some institutions on different continents. This suggestion was received favourably by the Instituto Geográfico Militar of Argentina. On the standard base line of Buenos Aires a distance of 480 metres was measured in 1953 by Drs. Kukkamäki and Honkasalo.<sup>4</sup> The accuracy of -0.05 millimetres, that is, 1:9,000,000 was reached.

The Survey of India took a highly positive attitude to the proposal of co-operation as indicated in a letter from Dr. Gulatee. The Survey expressed willingness to co-operate in the building of the posts and a shelter

kanen, "The Finnish 864-metre long Nummela Standard Base Line Measured with Väisälä Light Interference Comparator", *Bulletin géodésique*, No. 17, 1950 (Paris).

<sup>4</sup> T. J. Kukkamäki and T. Honkasalo, "Measurement of the Standard Base Line of Buenos Aires with Väisälä Comparator", *Bulletin géodésique*, No. 34, 1954.

<sup>1</sup> Y. Väisälä, *Die Anwendung der Lichtinterferenz zu Längenmessungen auf grösseren Distanzen*, Finnish Geodetic Institute report No. 2 (Helsinki, 1923).

<sup>2</sup> Y. Väisälä, *Anwendung der Lichtinterferenz bei Basis-messungen*, Finnish Geodetic Institute report No. 14 (Helsinki, 1930).

<sup>3</sup> T. Honkasalo, *Measuring the 864-m-long Nummela Standard Base Line with the Väisälä Light Interference Comparator and Some Investigations into Invar Wires*, Finnish Geodetic Institute report No. 37 (Helsinki, 1950); W. Heis-

for the comparator and in providing assistants. However, there were difficulties in financing the travelling expenses of the Finnish scientists who would carry out the observations.

It is understood that the question was discussed also in the Australian National Committee of Geodesy and Geophysics, but no information has been received on the final decision, and a new proposal must be made in order to bring the matter under reconsideration.

In recent years the Nummela base line has been remeasured, but these results have not yet been published. In accordance with the resolution of the Association, the standard metre used was measured by the Bureau international des poids et mesures. The result of this determination agrees within 0.4 micron with the earlier values.

At the Rome Assembly of the International Union of Geodesy and Geophysics, a resolution was passed to the effect that a standard base line should be established in each European country by using the Väisälä method (or similar apparatus) for assuring a uniform scale in all networks and for calibrating the invar tapes and geodimeters. Since, it was considered, it is not feasible for each country to obtain the special equipment for precise geodetic measurements, the Association resolved that the Central Bureau should initiate plans for the organization of an international base-line measurement party, with the equipment to be

supplied by some country possessing it already and the expenses of the personnel to be contributed by the countries actually engaged in the project. The Finnish Geodetic Institute has declared its willingness to make available its Väisälä comparator, as well as experienced members of the staff, on the condition indicated in the Association's resolution.

Here, in this Conference, a proposal made by India concerns the desirability of measuring one or more standard base lines in India and other Far Eastern countries with the Väisälä comparator developed at the Finnish Geodetic Institute. To this question, I have been authorized to reply that the Finnish Geodetic Institute will make available its comparator, as well as members of its staff to use it, and carry out all the necessary preparatory work in Finland, such as calibrating of the standard metres. The building of the concrete posts and a wooden shelter or protecting tents, as well as the travelling costs of the observers, would be paid, it is understood, by the country engaged in the project or by some international fund. The costs of the construction have been estimated at £500 according to European prices. The actual observations will take from six to eight weeks.

There is also the possibility that a Väisälä comparator may be purchased for this region; in such a case Finnish scientists will carry out the first measurements and train the local personnel to use the apparatus in further measurements.

# RECENT DEVELOPMENTS IN GEODETIC SURVEYING AND SUGGESTIONS FOR OTHER MAPPING QUESTIONS

*submitted by the*

*Delegation of the Federal Republic of Germany*

The original text of this paper appeared as document E/CONF.18/A/L.6/Rev.1 under the title "Ideas Concerning the Execution of Geodetic Surveys with due regard to Modern Developments to Simplify Classical Methods")

In Europe, surveying operations have in many cases taken more than one hundred years, the methods applied having a high degree of precision. At the beginning of such surveys, modern developments in the fields of physics, electrical engineering and chemistry are still unknown. Often the appropriate methods, that is, the "classical" methods, developed gradually during the work to meet specific requirements.

But if it should be desired nowadays to make such a geodetic survey of Europe again, the methods would differ from those applied in former years, making use of recent results obtained in scientific research. Application of these modern developments would involve an essential reduction in time—it is estimated that only about one-fifth of the time would be required—and thereby expenses would be reduced considerably without

proving prejudicial to precision. On the contrary, one may expect that modern procedures would also involve an essential increase in precision.

These considerations have led the delegation to submit articles by experts on different items dealing with the following subjects: (a) methods of expediting first-order triangulation; (b) distance measurements by modulation of high-frequency light waves; (c) standard base-line measurements; (d) necessity to repeat base-line measurements in the European triangulation net; (e) photogrammetric surveying and mapping of average accuracy; (f) land register; and (g) co-operation in international research. In part these articles refer to activities in Europe, in part to others in India and in part they deal with fundamental considerations.

## New Ideas to Expedite First-Order Triangulations

*by*

*Dr. Erwin Gigas*

*Director of the Institut für Angewandte Geodäsie*

An appraisal of first-order triangulations performed in Europe during the past one hundred years indicates that they do not give satisfactory results in the preparation of an absolute co-ordinate system. In contrast, the geodetic results achieved in Canada can be viewed with admiration. There a huge territory, nearly as extensive as Europe, has been covered with a coherent triangulation net in the course of a few years, by applying the Shoran trilateration method. Thus, Canada has shown how to cover within a short time the large unsurveyed areas of continents.

Nevertheless, the classical method of triangulation will not be eliminated completely by this recent development. It will retain its importance for completion of existing networks and for filling the wide-meshed triangles of trilateration, provided the geodesist endeavours to expedite the work by making use of other technical developments.

Three instruments are well adapted to increasing considerably the efficiency of the classical triangulation methods: (a) the theodolite with photographic registration; (b) the electric eye; and (c) improved lights.

### THEODOLITES WITH PHOTOGRAPHIC REGISTRATION

A first-order observation has its highest degree of precision only if performed in such a short time that the influences exercised by signal torsions during one set of readings in turn and subsequent back-turn, may be considered as equal values. This fundamental idea led to the construction of a theodolite with photographic registration. This device was needed because the observer's eye cannot adapt itself rapidly, after sighting a distant signal by telescope, adjusting the microscope and reading the micrometer.

Full particulars of a theodolite with photographic registration have been given in publications<sup>1</sup> and it

<sup>1</sup> E. Gigas, "Ein neuer Theodolit für Beobachtungen I. Ordnung" (A New Theodolite for First-Order Observations), *Nachrichten aus dem Reichsvermessungsdienst*, vol. 4, 1923 (Berlin), page 185; "Photographisch registrierende Theodolite" (Theodolites with Photographic Registration), paper submitted to the International Association of Geodesy, Oslo, 1948; *Teodoliti a registrazione fotografica*, published by the Catasto e Servizi Tecnici Erariali (Rome, 1949); "Theodolites with Photographic Registration", *Bulletin*



may be sufficient, therefore, to give an abstract in a few sentences. After sighting the target, the observer has but to push a release button, thus taking a photograph of the position of the graduated circles in relation to the fixed reading marks, both circle portions opposing each other in the image field as with a Wild or Zeiss theodolite. After development of the film, the coincidence is established by means of a micrometer, likewise with the above-mentioned instrument with optical determination of the mean. As the time required for reading the microscope and writing down the results is three or five times as long as that required for sighting, this amount of time is saved by photographic registration and the efficiency thereby increased threefold or fivefold. Owing to this acceleration of operations it is also possible to increase the number of aiming points within one set, thus proceeding to observe complete sets instead of single angles. Thereby a considerable expense for labour can be saved over that required by the French method, the Schreiber method of angular measurement in all combinations, and others. The time can be reduced by as much as 50 per cent. Finally, errors in recording cannot occur with this kind of registration and later on the results may be revised without repeating the measurements. The observations show a high degree of objectivity, being free from personal influences because of the fact that the observer himself does not immediately know the result of his measurements. It may be admitted that the observer has a certain feeling of insecurity at the beginning, but under certain circumstances the film can be developed at the station itself, and the evaluation of readings in the tent does not cause any difficulties. The observer is rapidly convinced of the reliability of this kind of measurement.

Considering the general desire not to over-extend the first-order triangles (maximum length of a triangle side thirty kilometres, if possible), the conditions of sighting will improve accordingly, thus generally eliminating all obstacles in this respect to observations in complete sets.

#### ELECTRIC EYE

Every observer engaged in first-order triangulation will have noticed that at night the target light is often of very irregular shape. In Germany, it is estimated that on only 10 per cent of the nights at most do the lights of the aiming points have the clear, star-like and pin shape the astronomer knows from his star observations. At other times the light has an irregular, very enlarged and constantly changing shape, so that the observer has the greatest difficulty in sighting the centre of the flash with sufficient accuracy. Attempts were made to manage with eyepiece micrometers, and, performing ten to twenty sightings therewith, it was assumed that the mean would represent the actual centre of the light. Without regard to the additional computations, this procedure is disadvantageous because

*géodésique*, No. 15, 1950, page 63, and No. 16, 1950, page 140; Askania Company, "Théodolite de Précision Askania d'après Gigas avec enregistrement photographique", *Bulletin géodésique*, No. 17, 1950, page 362.

of its considerable expenditure of time, thereby involving a possible but undefinable torsion of the signal.

These experiences led to experiments with electric sighting and finally resulted in the construction of the electric eye. With the telescope roughly sighted, the light ray emitted from a distant aiming point falls on a small plane-parallel plate (figure 1, A) in the eyepiece. This plate is in oblique position, half of its surface being covered with a reflecting silver layer.<sup>2</sup> The vertical crosshair of the telescope is replaced by the edged separation line of both halves of the plate. It depends on accurate sighting at the aiming point whether the light will pass either through the uncovered half of the plate, falling directly on a photoelectric cell (figure 1, B) or will fall on the silver layer and,

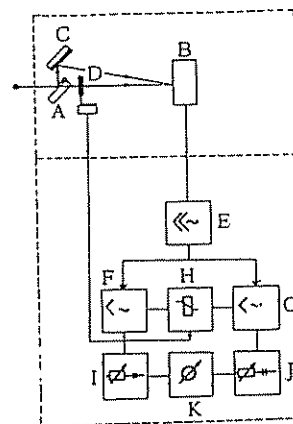


Figure 1

Diagram showing the principle of the electric eye

A Mirror in the eyepiece, half-silvered; B Photoelectric cell with secondary electron multiplier; C Auxiliary mirror; D Diaphragm; E Double stage low-frequency amplifier; F-G Single stage low-frequency amplifier; H Relays; I-J Integration systems; K Indicator

reflected by a small auxiliary mirror (figure 1, C), indirectly reach the same photoelectric cell. Moreover, the light rays may take partly the first and partly the second way, if they fall on the edged separation line between the silver layer and the uncovered half of the plate. A small diaphragm, D, with negligible mass and magnetically swinging in quick rhythm, covers alternately the direct or the indirect light ray reflected by the auxiliary mirror. If the target is precisely sighted then half of the light rays will reach the photoelectric cell directly, the other half indirectly by way of the mirror. The intensity of light is transformed by the cell into a very weak current, subsequently indicated by an indicator after adequate amplification by secondary electron multiplier, B, and one or two stepped low-frequency amplifiers (E, F and G). The current reaching the indicator alternates in the same rhythm as the swinging diaphragm, and therefore, the indicator, K, moving, will give the difference between

<sup>2</sup> As suggested by Dr. Bender; at first a rectangular prism was used.

two photoelectric currents. Thus, the indicator is in zero position if the telescope is precisely aimed on the target light. The relay, *H*, controls motion of the diaphragm, *D*, and the opening and closing of the channels, *F* and *G*.

Thus, the observer has only to watch the motion of the indicating pointer of the galvanometer when turning the slow-motion screw; as soon as the pointer reaches its zero position the reading is to be recorded and registered photographically. The instrument has the advantage that the galvanometer indicates the result of an automatic formation of the mean extending through 0.5 second approximately. For this purpose two integration systems, *I* and *J*, were designed, simultaneously admitting an adjustment of the intensities pertaining to the direct and the twice reflected light rays, thereby eliminating a zero-point error. In very slowly moving lights, particularly dangerous observations, it is possible to increase the duration of integration up to several seconds by adding electric resistances. Thus, being independent of atmospheric conditions, the observer has the possibility of making observations even on those nights hitherto unfit for observation because of the "bad lights".

Especially designed for first-order triangulation, this apparatus is exclusively applicable to horizontal measurements. It is possible, however, to use it also for impersonal registration with astronomical observations. For this purpose—according to a suggestion made by Dr. Bender—the small plane-parallel glass plate is divided into four fields in checkerboard manner, so that every two of the diagonally opposed fields are either uncovered or covered with a reflecting silver layer. The remaining device must be doubled: there are two photoelectric cells, two secondary electron multipliers, and two galvanometers necessary to control the horizontal and the vertical motions of the telescope. An automatic telescope drive could also be installed by adding some accessory devices of less importance.

The apparatus has also been described repeatedly in professional literature.<sup>3</sup> Figure 2 shows the first model of this instrument constructed in the laboratory. This construction has been carried out in detail and currently improved by Dr. Brein, a collaborator at the Institut für Angewandte Geodäsie.

As mentioned above, this apparatus was originally designed to make use of any night for the purpose of first-order triangulation, even with unfavourable lights. Later on tests showed that the precision of reading

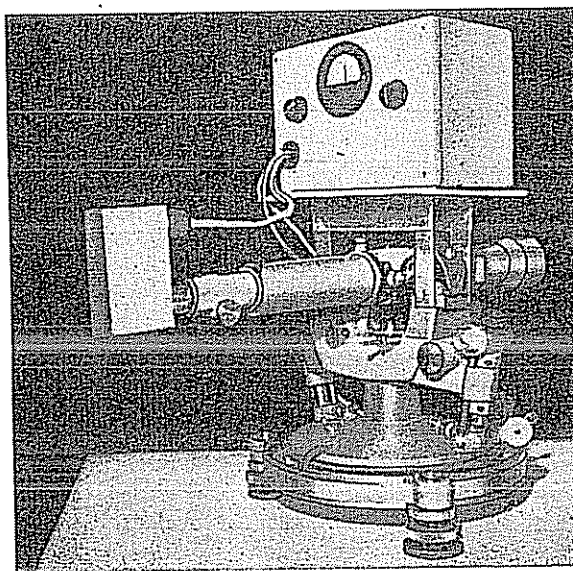


Figure 2. View of the electric eye, mounted on an Askania theodolite I O.

was essentially increased. The sighting error, previously about 0.9 second, has been decreased to 0.23 second with one sighting. This result has been confirmed by measurements in the laboratory cellar as well as in the open air at a distance of seventeen kilometres.

#### LIGHTS

The long distances of first-order triangulation require the application of lights at the target stations. In former years lights were used, the operation of which required a special assistant. In order to save the expense of the assistants, lights were used here and there; these were switched on and off at a fixed time, by clockwork. At present there are no technical difficulties in providing a source of light with an aerial and relay, switched on and off by emission of electrical impulses from the observation station. When the observation station is changed, a readjustment of the light may be avoided by installing special devices to adjust it automatically to the new direction and, if necessary, to control the elevation setting by wireless impulses, when the new observation station is established.

These devices are profitable for two reasons: the expense for assistants is saved and, moreover, the storage batteries are used only during the actual observation. The application of the devices described would essentially shorten the time of observation required for first-order triangulation. In general it will be possible with these instruments to realize the ideal of completely observing one first-order station during one night.

<sup>3</sup> Kron and Withford, *Review of Scientific Instruments*, vol. 8, 1937 (Chicago), page 78; Gigas, Wunsch and Ziegel, German Patent No. 819 461.1949; E. Gigas, "The Electric Eye", *Geofisica Pura e Applicata*, XVIII, 1950 (Milan); E. Gigas, "Infrarot in der Triangulation I. Ordnung" (Infrared in First-Order Triangulation), *Geodätische Woche in Köln*, 1950 (Geodetic Week at Köln, 1950) (Stuttgart, 1951).

# Development of a Method of Measuring Distances by Modulation of High-frequency Light Waves

by  
Dr. Erwin Gigas

The first attempts at measuring distances<sup>4</sup> or determining the velocity of light at a given distance by means of modulated light waves date back to 1925, when the interruption of light, originally carried out by Fizeau by means of a rotating wheel, was brought about by Karolus<sup>5</sup> through an electro-optical light control without inertia, making use of the Kerr effect. Even in 1893 the Kerr effect was used by De Coudres to measure the frequency of Hertz waves. Subsequently,

With an alternating voltage of  $e_0 \sin \omega t$  is

$$\theta = \frac{f'}{a^2} e_0 \sin^2 (2 \pi \nu t).$$

The Nicol prism  $N_2$  is turned 90 degrees with respect to  $N_1$ , so that behind  $N_2$  a periodically interrupted light of frequency 2 appears, because two light impulses

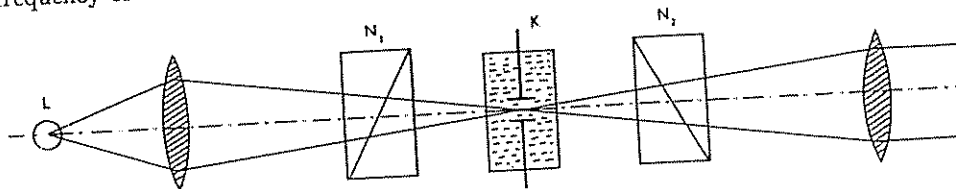


Figure 3. Diagram showing Kerr cell and optical arrangements

in the ensuing twenty years, many scientists have applied this effect to different research, but it is the merit of Karolus to have been the first to describe the optical arrangement, found in the modern instruments of E. Bergstrand and of the Institut für Angewandte Geodäsie.

Light emitted by the light source  $L$  (figure 3) is linearly polarized by the Nicol prism  $N_1$  being arranged in such a manner that the polarization plane is inclined by 45 degrees to the electric field of the Kerr cell  $K$ . The Kerr cell is a glass vessel filled with nitrobenzene,

arise in each period due to the square relation between voltage and double refraction. The intensity  $J$  of the appearing light is, according to W. Ilberg,<sup>6</sup>

$$J = \frac{J_{\max}}{2} \left( 1 - \cos f' \frac{V^2}{a^2} \right)$$

In 1928 A. Hüttel<sup>7</sup> made the next step by introducing a photoelectric tube (figure 4). The action of the Kerr cell had been carefully studied by Ilberg. This research was fundamental for the activities of Hüttel and, in

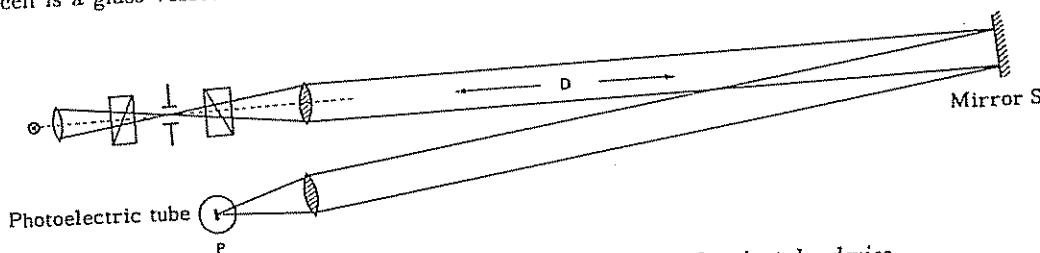


Figure 4. Apparatus in figure 3 with a photoelectric tube device

with two electrodes dipping into it. With a certain voltage, the light coming from  $N_1$  is thereby elliptically polarized. The double refraction  $\theta$  of the Kerr cell is, according to Kerr,

$$\theta = \frac{V^2}{a^2} \frac{2 \pi B l}{300^2} = \frac{V^2}{a^2} f'$$

where  $B$  is the Kerr constant,  $V$  the Voltage,  $l$  the plate length, and  $a$  the plate distance.

<sup>4</sup> O. Mittelstaedt, *Die Bestimmung der Lichtgeschwindigkeit unter Verwendung des elektrooptischen Kerreffektes* (Determination of the Velocity of Light by Application of the Electro-optical Kerr Effect), dissertation (Leipzig, 1929).

<sup>5</sup> *Leipziger Berichte der Sächsischen Akademie 1925* (Reports of the Saxon Academy for 1925), 7 December 1925.

modern times, for Bergstrand and the Institut für Angewandte Geodäsie.

Experience has proved that the Kerr cell with distance between its electrodes of about two millimeters has a characteristic curve (figure 5), showing only a little rise in light intensity with a voltage up to 5,000 volts but subsequently up to 8,000 or 9,000 volts this rises

<sup>6</sup> W. Ilberg, *Physiker Zeitschrift*, vol. 29, 1928, page 6.

<sup>7</sup> A. Hüttel, "Eine Methode zur Bestimmung der Lichtgeschwindigkeit unter Anwendung des Kerreffektes einer Photozelle als phasenabhängigem Gleichrichter" (A Method to Determine the Velocity of Light by Application of the Kerr Effect and a Photoelectric Tube Phase-dependent Rectifier), *Annalen der Physik*, vol. 1940.

considerably greater; afterwards, with a still higher stage, it begins to decrease again.

Hüttel's endeavours, as well as Bergstrand's, aimed making use of the alternating voltage pertaining the straight portion of the characteristic curve. As Hüttel operated with a direct current voltage of 5,000 volts, approximately, superimposing thereon a high-frequency alternating voltage of  $\sin \omega t$  of 2,000 to 3,000 volts, thus placing the operation point in the approximate middle of the straight portion of the characteristic curve. Then the voltage<sup>8</sup> is of the following form:

$$e = E_m + E_0 \sin \omega t,$$

whereas the light current leaving the Kerr cell has the form:

$$i = J_m + J_0 \sin \omega t.$$

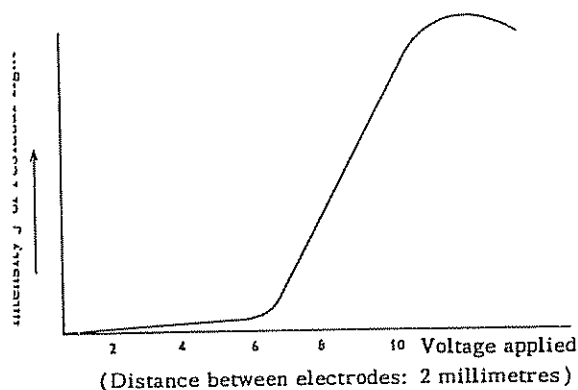


Figure 5. Characteristic curve of the Kerr cell

The light current (figure 4), having passed through the distance  $D$ , is reflected by the plane mirror  $S$  and finally absorbed by a photoelectric tube arranged at the beginning of the distance  $P$ . A photoelectric tube consisting of alkaline metal constitutes a rectifier for alternating currents, because the electrons emitted by the light can only reach the anode if it is positive with respect to the cathode.

As the efficiency of a photoelectric tube is low (about one per cent, that is, 100 light quanta release but one electron), this photoelectric tube must be selected carefully, corresponding to the light applied. If an alternating voltage is used for the photoelectric tube, then a photoelectric current will flow only during the positive half-cycle. The characteristic curve of a photoelectric tube shows a speedy rise up to a saturation point, already reached with 100 volts approximately, and subsequently only increases a little.

The Kerr cell and photoelectric tube are fed by the same oscillator, that is, the light intensity released by the Kerr cell oscillates with the same frequency as the voltage of the photoelectric tube or the suscepti-

bility of the photoelectric tube. Therefore the photoelectric current is the arithmetical mean of the light current absorbed by the photoelectric tube during the positive half-waves:

$$P = \int_0^{\pi/2} i dt$$

where  $i$  is the momentary value of the light current modulated in sine waves. Since the light current has passed through a certain distance  $D$  both ways before falling upon the photoelectric tube, this retracing light current, absorbed by the photoelectric tube, will not be in phase with the light current emitted. Figure 7 illustrates some examples<sup>9</sup> for a phase difference of  $\theta = 0$ ,  $\theta = \pi/2$  and  $\theta = \pi$ .

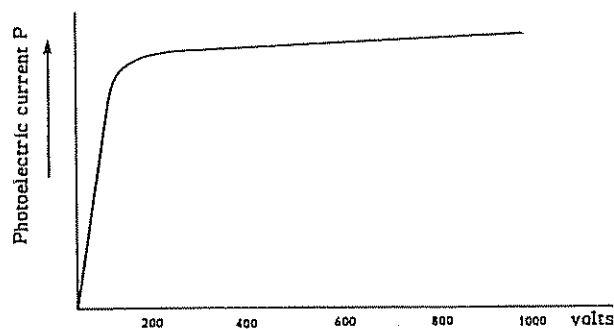


Figure 6. Characteristic curve of the photoelectric tube

With reference to figure 6 the opening curve of the photoelectric tube is assumed to be almost of rectangular shape. The light current has the form of sine waves.

According to Hüttel, the photoelectric current for any distance passed through by the light with a phase difference  $\theta$  is:

$$\begin{aligned} P &= \int_0^{\pi/2} [J_m + J_0 \sin(\omega t + \theta)] dt \\ &= \frac{J_m}{2} + J_0 \int_0^{\pi/2} \sin(\omega t + \theta) dt, \end{aligned}$$

where  $J_m$  is the light intensity produced by the direct current voltage  $E_m$  applied to the Kerr cell, and  $J_0$  the light intensity produced by the high-frequency alternating voltage  $E_0$  applied to the Kerr cell. The photoelectric current, depending on the way the light passes, has a sine-shaped curve and is dependent on the phase difference between photoelectric voltage and the retracing light current. The space between maxima and minima is  $2\pi$  at times. Hüttel draws attention

<sup>8</sup> Bergstrand used a low-frequency alternating voltage of 50 cycles per second instead of the direct current voltage.

<sup>9</sup> A. Hüttel, *op. cit.*, page 368.

to the fact that the accurate determination of these maxima and minima is very difficult. Therefore he recommends the measurement of such points, located on the rising or falling of the sine-shaped curve, that is, at points of a maximum temporal variation.

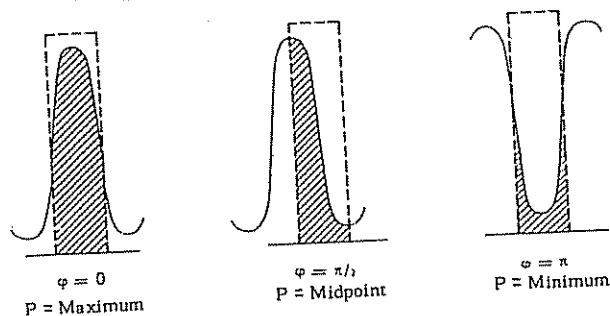


Figure 7. Examples of phase difference

This idea had likewise been adopted by Bergstrand,<sup>10</sup> who superimposed the high-frequency alternating voltage upon the low-frequency 50-cycle rectangular voltage, thus obtaining an efficient apparatus for measurement of distances. Besides the above-mentioned fact that Bergstrand replaced the direct current voltage of the Kerr cell (space between poles 2 millimetres) by a low-frequency alternating voltage of 50 cycles with an amplitude of 6,200 volts, superimposed by a high-frequency alternating voltage of 8.33 megacycles with an amplitude of 1,200 volts, he moreover conducted—as a new invention—the photoelectric currents, alternating with a frequency of 50 cycles per second, in inverse directions to an ammeter, which thus indicates the difference of both these currents:

$$J = (J_{50+}) - (J_{50-})$$

When the distance covered is an even multiple of the wave length  $\lambda$  of the light, which traverses the measuring distance as a modulated wave produced by the high-frequency alternating voltage, the galvanometer ought to indicate zero. The different electric effects in this apparatus, however, caused a certain delay in the different parts of the apparatus which was determined as a constant factor by means of an experimental distance. The fundamental principle, however, will not be influenced thereby.

But in general, the measuring distance will not be an even multiple of the wave length. It will be necessary, therefore, either to shift the mirrors until this is the case or—according to Bergstrand—to provide the apparatus with a loop of light which is continuously variable in order to adjust the distance.

Originally Bergstrand had to know the approximate value of the measuring distance in order to compute therefrom the number of even multiples of the wave

lengths. Thereby, the possibilities of application were considerably restricted. The modern geodimeter, therefore, has two quartz crystals of different frequency, which make it possible to perform a second and independent measurement of the same distance by means of another frequency. The combination of both these results, moreover, admits the determination of the number of entire wave lengths, thus rendering it superfluous to know the approximate value of the distance.

At present the geodimeter is a valuable addition to instruments for geodetic measurements and can hardly be overlooked in land surveys. The problem of scale revision in large area triangulation networks could probably find a quick and satisfactory solution in the near future by making use of the geodimeter.

Bergstrand's different publications on the results obtained with the geodimeter induced the Institut für Angewandte Geodäsie likewise to study these problems. At first an effort was made to replace the Kerr cell, which is not very well suited for field use and to perform the light modulation by other methods. Experiments made by Dr. Maurer to obtain a modulation by means of a cathode-ray tube failed because of the long duration of incandescence on the fluorescent screen. Another attempt to obtain a modulation by means of a field of standing ultrasonic waves, likewise proposed by Dr. Maurer, has not given satisfaction. Thereupon Nottarp used a Kerr cell, the electrodes of which were minimally spaced, and good functioning of the cell at an essentially lower voltage is expected.

Moreover, Nottarp, using only one oscillatory circuit and avoiding the loop of light, tried to attain the objective of distance measurement by operating with a frequency which can be varied within certain limits. Since similar experiments had failed in former time because of the low constancy of the frequencies, a simple adjusting device was built, the operation of which took such a little time that the speed of measurement was not essentially influenced thereby.

Finally, great importance was attached to the fact that this apparatus would be suited for measurement of closed traverses, since in geodesy appropriate instruments for distance measurement are not yet available with respect to precision traverses with long sides (more than 200 metres). If successful in measuring quickly and precisely the closed traverses consisting of average sides of one metre's length, the third-order triangulation (perhaps even that of second-order) might be replaced by such traverses. Then the check points would no longer be located on mountains difficult of access but at main roads, waterways, railway lines etc., that is, where these points are necessary for subsequent measurement of details. Restricting ourselves to shorter distances (up to four kilometres approximately) we could essentially reduce in size and simplify the optical parts of this apparatus, compared with that of Bergstrand.

These fundamental considerations led to a new instrument which was built in the Institut für Angewandte Geodäsie as a trial model, called EM, apparatus. This instrument is shown in figure 8. It has the advantage of a theodolite, may be placed on the usual tri-

<sup>10</sup> E. Bergstrand, "Measurement of Distances by High-Frequency Light Signalling", in *Proceedings of the Baltic Geodetic Commission, 1944-1947*, page 101; "A Determination of the Velocity of Light", *Arkiv för Fysik*, vol. 2, No. 15, 1950; "A Check Determination of the Velocity of Light", *Arkiv för Fysik*, vol. 3, No. 26, 1951.



its size could possibly be further reduced in quantity of construction which is envisaged by the Askania Company. The principle and method of operation of this instrument are illustrated in figure 9.

By means of a good lens the image of a light source (high-pressure mercury-vapor lamp) is projected between the plates of the Kerr cell. Before entering the Kerr cell the light beam passes through a Nicol prism. The pole plates, spaced 0.2 millimetres apart, are wedge shaped in order to prevent the light rays from touching the borders of the pole plates. Leaving the Kerr cell, the light beam has to pass—as originally in Hüttel and Mittelstaedt—through a second Nicol prism turned 90 degrees with respect to the first, thus extinguishing the light unless a voltage is applied to the Kerr cell. Controlled by alternating voltage, the Kerr cell effects the following: in the rhythm of the stage variation a modulated light current leaves the second Nicol, passes through an intermediate lens and

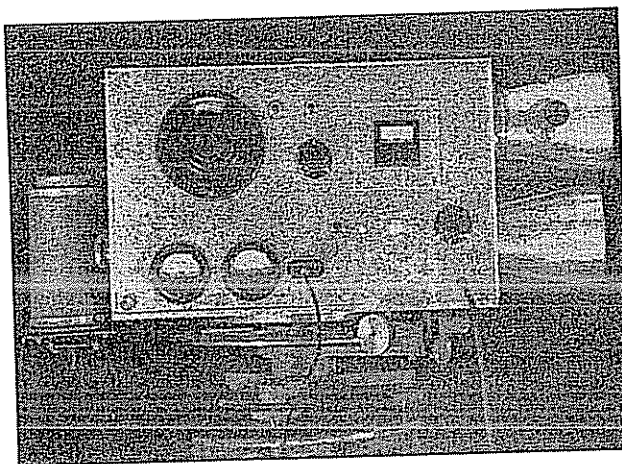


Figure 8. Photograph of  $EM_c$  apparatus

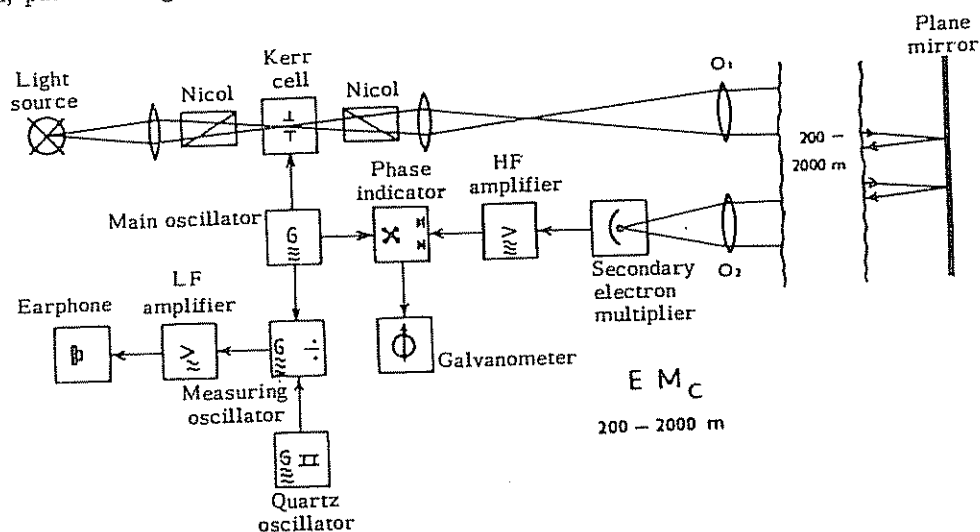


Figure 9. Diagram of  $EM_c$  apparatus

reaches the objective, lens  $O_1$ . From there the light passes the measuring distance as a beam of parallel rays, is reflected by the plane mirror at the end of the trajectory and, having passed through the objective, lens  $O_2$ , located at the beginning of the trajectory, the light is absorbed by a photoelectric tube. In this photoelectric tube the intensity of the light beam, varying constantly corresponding to the high-frequency alternating voltage of the Kerr cell, is converted into a photoelectric current and subsequently amplified one million times, approximately, by means of a secondary electron multiplier. After flowing through a high-frequency amplifier, which incidentally causes a phase inversion, these high-frequency photoelectric currents reach a phase indicator admitting a phase comparison between the emitted and reflected light-waves.

The practical realization of this measuring procedure differs essentially from Bergstrand's construction. The abandonment of spheric mirrors combined with the use of a normal telescope lens reduced the range

of the apparatus but, on the other hand, an essential reduction in size is thereby obtained. In its definitive form this instrument will not exceed the size and weight of a second-order theodolite and may be placed on the customary tripods for theodolites and used, under certain circumstances, in connexion with a device for accurate orientation.

For the most part the electric installation has been developed by Nottarp, a collaborator at the Institute. Because of the small space between the pole plates in the Kerr cell, this device works with a relatively low high-frequency voltage, 20 megacycles. Since, in this case, the Kerr cell acts independently of the mathematical sign pertaining to the voltage applied, a doubling of frequency occurs. A part of the wave cycle is suppressed, because the characteristic curve of the Kerr cell is controlled in its lower part (see figures 10 and 11). A twofold steep and even shorter execution of the emitted light impulses is thereby obtained. The oscillation, directly applied to the phase meter and to the

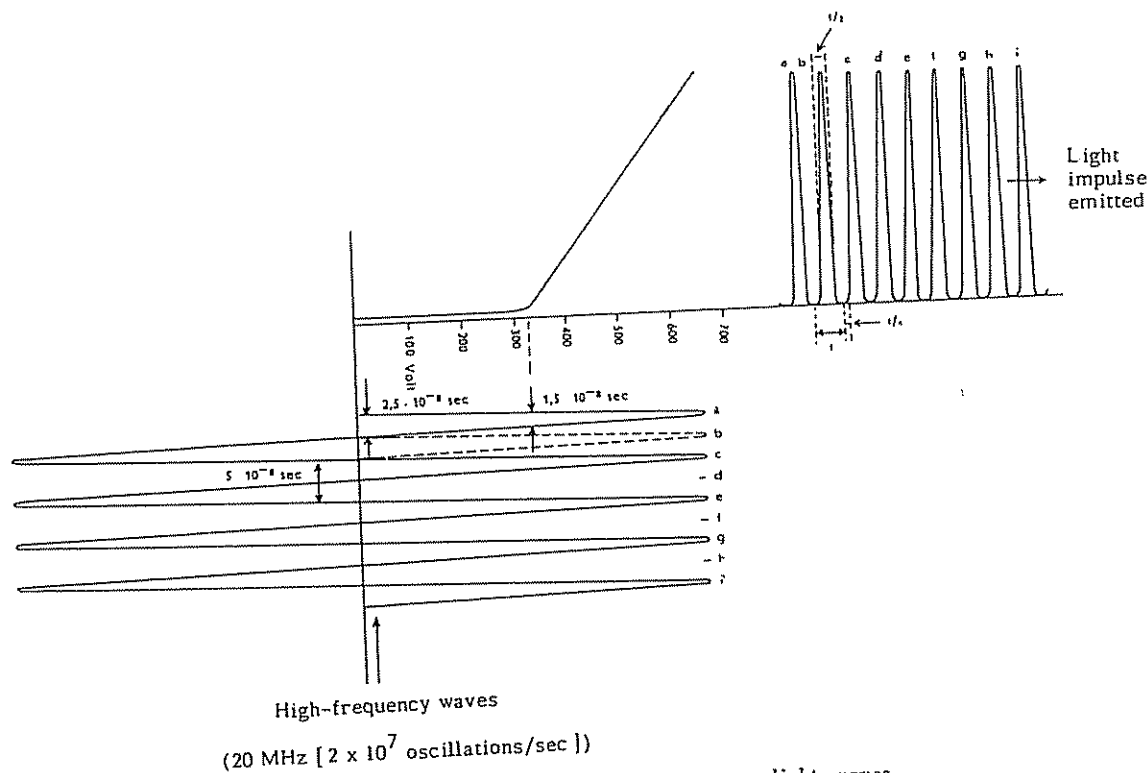


Figure 10. Modulation of high-frequency light waves

secondary electron multiplier, is likewise doubled by the connexion chosen.

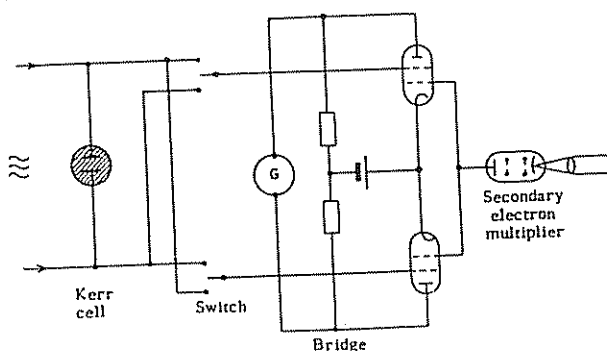


Figure 11. Phase meter

The time required for the light impulse to pass through the secondary electron multipliers, however, is equal to the width of impulses because of the finite velocity of electrons. Thereby, with phase synchronization—and only with an accurate phase synchronization—the arriving impulse can just pass through the multiplier opened with a period of 40 megacycles. With a phase difference, on the other hand, the oscillator current will not be balanced by the light current in the phase meter. Therefore, the galvanometer indicates a swing of the pointer, disappearing only in the case of phase synchronization. In order to eliminate zero-point errors a pole-changing switch is arranged at the phase indicator.

The main oscillator (figure 9) oscillates with a frequency of about 20 to 21 megacycles per second. This frequency is obtained by fivefold multiplication of the frequency of the measuring oscillator (4.0 to 4.2 megacycles per second).

The measuring oscillator is adjusted in such a way that it is connected with a headphone after having passed through a low-frequency amplifier. Then the frequency of the measuring oscillator is derived from the 40th, 41st or 42nd harmonic oscillation of the frequency oscillator, the constancy of which is characterized by a maximum of  $\pm 5 \times 10^{-8}$ . These harmonic oscillations, being perceived with extreme acuteness, admit an adjusting of the measuring oscillator to  $\pm 1 \times 10^{-7}$ . The same accuracy is assured for the main oscillator.

The measuring procedure is as follows. At first the pole-changing switch is revolved into "adjusting position", thus adjusting the scale for the measuring oscillator, which will hardly take more than one minute. Then the same switch is revolved into "measuring position" and, by turning a condenser knob, the phase synchronization is obtained, that is, the zero position of the galvanometer. The appropriate scale value is read off. A further turning of the knob causes a swinging of the galvanometer pointer, which will subsequently return to the zero point, if instead of

preceding wave length of  $\frac{\lambda}{2}$ ,  $(n + 1)$  or  $(n - 1)$  en wave cycles accurately cover the measuring distance. This procedure may be extended in both directions thus obtaining from four to five independent meas-

its. Thereby four or five frequencies or their corresponding wave lengths  $\lambda$  will result, for which following relations are given :

$$2 E = \frac{x \times \lambda_0}{2},$$

$$2 E = (x - 1) \left( \frac{1}{2} \lambda_1 \right),$$

$$2 E = (x - 2) \left( \frac{1}{2} \lambda_2 \right),$$

$$2 E = (x + n) \left( \frac{1}{2} \lambda_n \right).$$

Two of these equations are sufficient for computation the distances measured or for reading them off from tables. The whole measuring operation hardly takes more than two to three minutes. Thereafter the pole-ranging switch is revolved back into "adjusting position", thus repeating the adjustment, performed at the very beginning, during the subsequent minute. Because of the short interval a variation of the adjustment values will not take place in general. Should such a variation be observed, however, due to a longer duration of measurements, the appropriate adjusting value may be obtained by interpolation. In this case,

however, it would be easier to repeat the measurement which, as mentioned above, can be performed within five minutes, including adjusting.

This apparatus has been manufactured as a trial model by the Institut für Angewandte Geodäsie and its utilization qualities have been examined with short distances in the laboratory cellar. Field experiments are being made. They will give, above all, a general view considering the range of the apparatus, which is estimated to be three kilometres, approximately. This would be quite sufficient for the purpose intended—use for distance measurements in closed traverses of high precision.

At present these measurements can be performed only at nightfall and during the night. But a very skilful modification, developed likewise by Nottarp, will make it possible to use this instrument by daylight too. This aim will be attained by another arrangement of the second Nicol prism. It will no longer be intercalated in front of the objective lens for the emitted light but behind the objective lens for the reflected light.

The purpose of this paper is to show in what ways it will be possible to make use of recent methods of modern physics for geodetic purposes through step by step development. These developments are not yet completed, but even in their present form these instruments will be useful for geodetic measurements.

## Measurement of Standard Base Lines

by

*Dr. Erwin Gigas*

About 100 of 150 years ago, when national surveying began in Europe, the technical conditions were essentially different from those existing today. It would be a complete failure, therefore, to keep to the pattern of the ancient classical methods when performing major geodetic projects. As technical development has made such important progress in the last decades, it may fairly be said that in the whole world no geodetic manual exists taking this into account.

In examining the expediency of major geodetic projects we completely depend on the experience of the experts in the last two decades. Evidently it would be an important task for the geodesists of the world to publish their experience in this sphere in order that it might become general knowledge among experts. On this occasion I should like to suggest that a progressive manual of land surveying be created through the co-operation of the geodesists of the whole world, wherein the different experts report in special chapters on their respective activities.

The desire, expressed in sub-item 6 (a) (ii) of the agenda, to establish standard base lines in India and other countries of the Far East is fully justified and should meet with our utmost aid. The existence of a standard base line of sufficient length in a country is required, at any rate, regardless of whether one follows the classical methods of base-line measurements

or decides to apply the most modern electronic instruments for distance measurement.

The question of how to measure such a standard base line has not yet been sufficiently resolved, in my opinion. The interference comparator of Väisälä, it is true, is quite an excellent instrument for precision measurements. For many decades measurements have been made with this instrument on Finnish base lines, and measurements, in Finland and recently also near Buenos Aires, have been extended to a length of nearly one kilometre. Moreover, the inner accuracy, aside from the consideration of systematic influences, is a very high one. But we do not know the degree of absolute accuracy, since comparable measurements are lacking. These comparison measurements, however still may not be performed with the same instrument, but another device has to be applied under extremely different conditions. Until such a comparison is made we are not in a position to judge of the actual accuracy.

The Finnish interference comparator still shows certain defects, the influence of which on the result cannot be predicted offhand. These are due to (a) uncertainty in determining the standard metre (a quartz metre bar with spherical ends can hardly be determined with higher precision than  $\frac{1}{2} \mu$ ); (b) effects of compensators, which may cause errors up to several  $\mu$  with each magnification.



Unfortunately, the idea of Väisälä has not yet been taken up by other nations. It was Germany alone that carefully studied the apparatus, trying to apply certain improvements. The paper submitted by E. Gigas at the Rome assembly, entitled "Über die Frage der Notwendigkeit der Wiederholung von Basismessungen in Europäischen Dreiecksnetz" (The Problem of the Necessity to Repeat Base-Line Measurements in the European Triangulation Net) reported on the realization of these improvements.

If it is actually intended to obtain an absolute value of comparison for distance measurements, then it will be necessary that the standard base lines be measured in different ways and by using different instruments in order to guarantee the reliability of the single measurements. Perhaps we should not be against performing these comparison measurements by means of invar tapes, the length of which has been checked with different standard distances, located at such places as Washington, Teddington, Braunschweig and Paris. After execution of these measurements the tapes have to be checked anew with the standard distances.

When adjusting the European triangulation net we checked more than forty base lines determined by means of different instruments for base-line measurements. Though each base line had been measured with all possible precautions and though the instruments were checked before and after measurement in authorized institutes, there arose systematic errors amounting to about  $\pm 3$  millimetres.

When connecting triangulation nets, however, the influence of distance measurements is considerable. And now, when asked to express our opinion as Europeans concerning the value of standard base lines, we should by no means suppress our negative experiences. On the contrary we ought to invite attention to all weak points involved in this most difficult problem of geodesy, "a distance measurement free from systematic errors".

## Problem of the Necessity to Repeat Base-Line Measurements in the European Triangulation Net

by

Dr. Erwin Gigas

When adjusting the central European part of the European first-order triangulation net, detailed investigations were made concerning the base material existing in central Europe. Reports on the results of these investigations have been given by G. Strasser,<sup>12</sup> which showed that the base measurements in that region, performed by different nations with different base instruments, contained many systematic errors extending to about  $\pm 2.5$  millimetres per kilometre. The

<sup>12</sup> Georg Strasser, "Kritische Betrachtungen zur Messung und Vergrößerung von Grundlinien" (Critical Remarks on Measurement and Enlarging of Base Lines), dissertation (Munich, 1950); *Die Grundlinienausgleichung im Zentraleuropäischen Netz* (The Base-Line Adjustment of the Central European Net), Publication No. 5 of the Institut für Erdmessung (Bamberg, 1950).

I take the liberty, therefore, of suggesting that you should not restrict yourself to one single apparatus for establishing base lines. I suggest that, besides the Finnish interference comparator, the German interference comparator should be used by way of comparison and that, moreover, the base lines should be measured likewise by means of first-rate invar tapes that have been observed for many years.

The importance of the location of such a base line should not be underestimated. The base line should be easy of access to traffic and located in an area which may be considered as free from geological objections, so that it may be predicted—according to human judgment—that the geological strata will not be subject to variations, endangering the accuracy of the distance measurement in years to come. It is likewise very important in what way the base line is marked in the ground; it would be profitable to refer to experiments made in other countries. In my opinion the markers in the ground as described by Dittrich<sup>11</sup> are of the most reliable character up to the present.

In the last decades, valuable experience has also been gained with measurements by means of invar tapes, essential reports of which have not yet been published though they are of decisive importance for the execution of these precision measurements. I am thinking, for instance, of the use of appropriate stretcher devices, pulley supports, and so on. Later on, when executing base-line measurements in the field, we should endeavour to measure whole triangle sides instead of shorter base lines to be subsequently extended to first-order triangle sides by means of expansion figures, for the decrease in precision with base expansion figures has been frequently investigated and stated to be considerable.

<sup>11</sup> E. Gigas, *Handbuch zur Verwendung von Invardrähten bei Grundlinienmessungen* (Manual for the Use of Invar Wires for Base-Line Measurements).

amount of systematic error depends on (a) the base instrument used; (b) the calibration of the base instrument, and (c) the institute performing the calibration.

The United States is fortunate in that these three items are regularly the same with all base measurements so that only one uniform systematic error can result for the whole country. In Europe, as well, some countries may assume that this condition exists with their own base measurements. In central Europe, however, this supposition is not correct. All three of these items change frequently, and Strasser derived a whole series of different systematic errors caused by this variety. Often these systematic errors were characteristic as to their absolute value or their sign so that it was possible, for instance, to indicate—merely

taking account of the sign, without any information about measuring and gauging conditions—what kind of base instrument had been used for measurement, what method of calibration had been applied, and which institute had performed this calibration.

In view of the lack of uniformity in the central European base measurements, it would be desirable, of course, to repeat them. In this connexion the question arises whether it would be better to resurvey these base lines by means of a new and improved base instrument or to examine directly the triangle sides by taking advantage of the possibilities of Bergstrand's geodimeter. The favourable results obtained by measurements with Bergstrand's instrument would certainly recommend its use for a scale revision. In contrast, a repetition of base measurements with modern instruments would require considerable expense for preparatory field work with the base line and would also presuppose that the base expansion figures satisfy all requirements of the modern technique of angular measurement. This is not true, however, with the central European triangulation net in general. The reports of measurements of base expansion figures have sufficiently demonstrated that it is particularly these observations which often cause the influences of horizontal refraction to have detrimental effects and that even the accuracy of highly precise base-line measurements has been lost by expansion on the main triangulation sides.

On the other hand, Bergstrand has proved by various observations in Sweden that his procedure is highly precise. Also, extensive test observations with this instrument, made in the United States, have confirmed the high accuracy of this observation method.

In my opinion the most profitable method of scale revision would be to use this geodimeter, detailed reports<sup>23</sup> of which have been given, so that further particulars will not be necessary.

In countries where the three items mentioned above are the same for all the base measurements performed, it would suffice to determine one or a few base lines by means of the same base measuring instrument for comparison in the different countries, to guarantee international unity in the scale and to determine systematic errors. The Bergstrand instrument would certainly be a suitable means for performing these comparisons, considering that in the different countries the same instrument must be used by the same group of operators.

Besides the use of a generally approved base measuring instrument, there is another possibility. Nearly all countries are now in possession of a reference base line, generally observed before and after each base measure-

<sup>23</sup> E. Bergstrand, "Measurement of Distances by High-Frequency Light Signalling", *Proceedings of the Baltic Geodetic Commission, 1944-1947*, page 101; "Determination of the Velocity of Light", *Arkiv för Fysik*, vol. 2, No. 15, 1950 and vol. 3, No. 26, 1951.

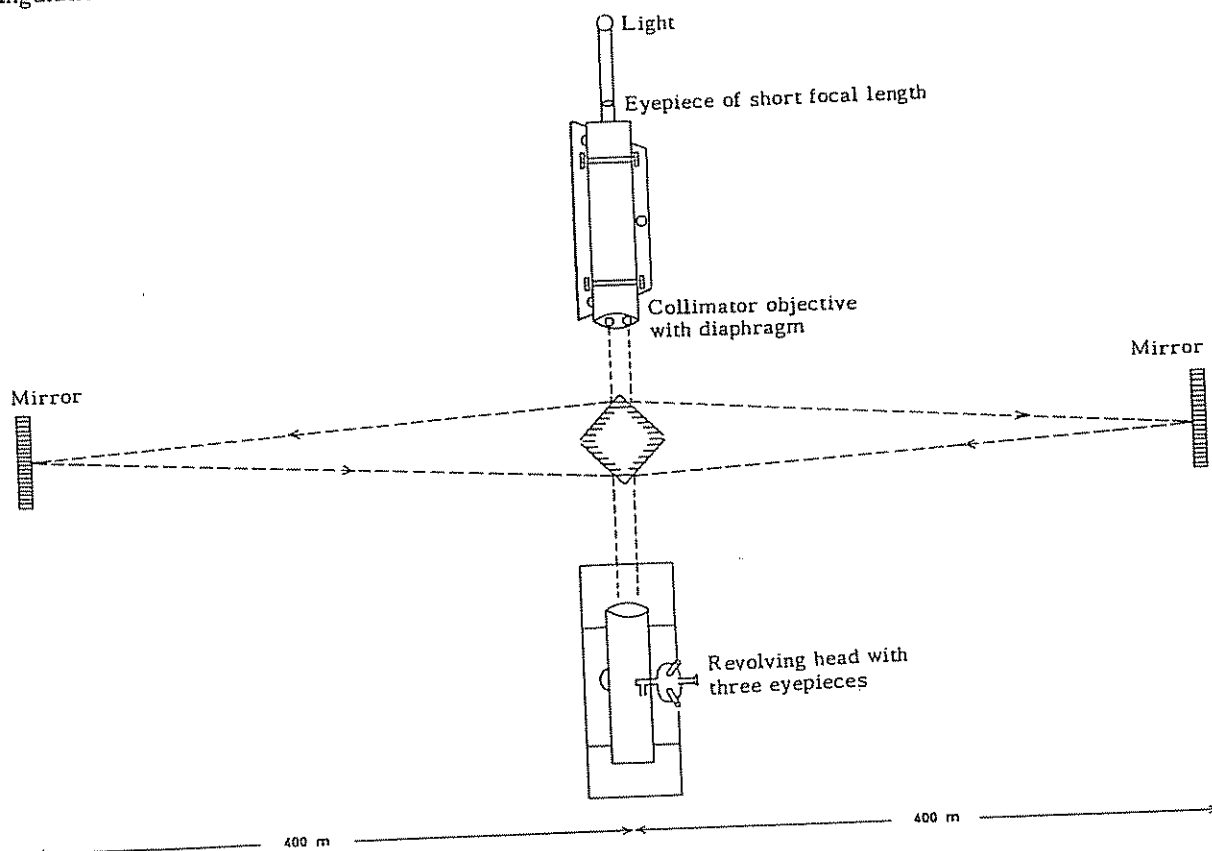


Figure 12. Diagram of operation of Väisälä interference comparator

ment, thus guaranteeing uniformity. The task of determining systematic errors, therefore, would involve the problem of reobserving these base lines, extending to an average length of 600 to 900 metres, by a suitable checking instrument, such as Väisälä's interference comparator, recommended by the Finnish Geodetic Institute. During the meeting of the International Association of Geodesy in Brussels, in 1951, the Finnish delegation reported that by means of this instrument they had succeeded in measuring base lines up to 860 metres in northern latitudes. It was proposed that investigations should be made in other countries to ascertain whether this method might also be applicable to longer distances with unfavourable conditions in middle latitudes.

The Institut für Angewandte Geodäsie (Institute for Applied Geodesy) in Frankfurt, which has a Väisälä interference comparator, has followed this suggestion, and experimental studies have been made to determine the range of this apparatus in 50 degrees north latitude and in unfavourable atmospheric conditions. Up to this date Väisälä's procedure has been extended without difficulty to a distance of 100 metres and there is legitimate hope, therefore, of reaching a distance of approximately 400 metres. Should it not be possible to extend further the distance of observation, it is planned to determine the total length by comparing two distances of 400 metres, one of which has already been measured according to Väisälä method (figure 12). A further doubling would make it possible to measure distances of 1,200 and 1,600 metres, also by 400-metre sections.

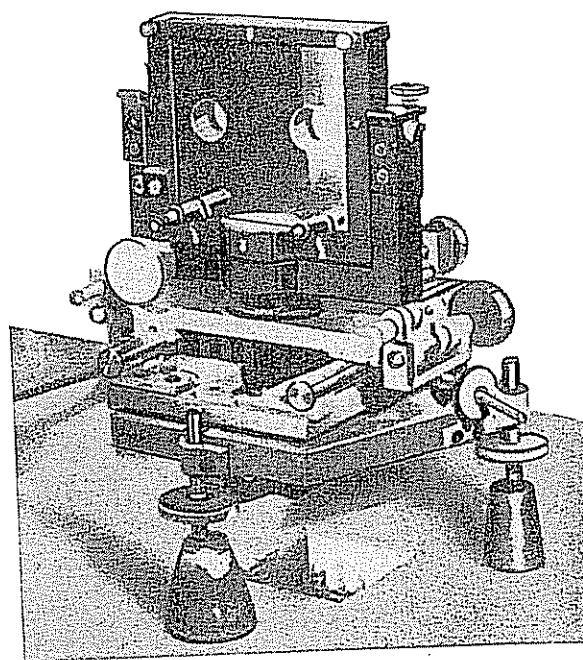


Figure 13. Mirror mounted on supports

In this connexion it may be appropriate to give some particulars concerning the Väisälä interference comparator installed by the Institut für Angewandte Geodäsie, which differs essentially in construction from the one installed in Finland.

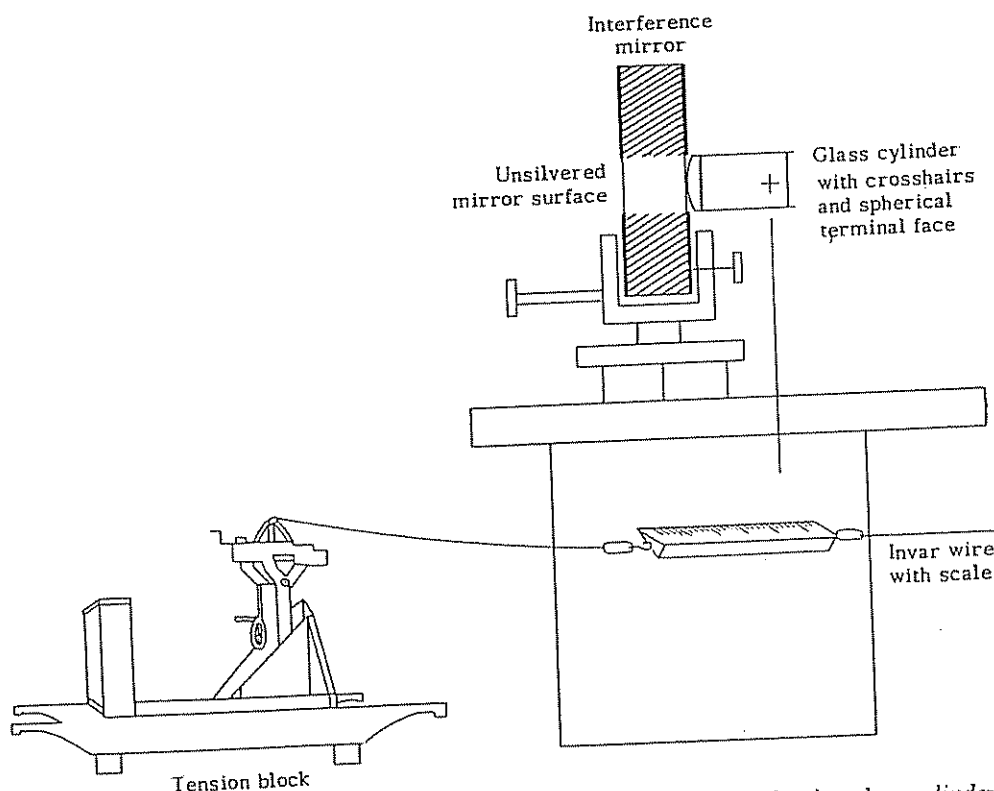


Figure 14. Transfer of interference distance to measuring tape : diagram showing glass cylinder method.

Through the aid of Professor I. Bonsdorff, in the early nineteen thirties, the Finnish comparator was rowed to check the length of the reference distance at Potsdam. Being set up at the reference base, the apparatus was used for calibration of wires, and subsequently for measuring the reference distance. While working with this very useful instrument, the German observers expressed the desire to have a similar apparatus of their own and to improve some constructive details, namely:

(1) To construct the mirror stands in such a way that micrometric displacements of mirrors would be possible, thus eliminating the use of compensator plates within the observation telescope, as these plates

caused inaccuracies due to dispersion, amounting to  $7 \mu$  per 6 metres after first multiplication.

(2) To avoid stretching the wires across the mirror supports, which might cause—in spite of the greatest care—small variations of the reading marks. Instead, attempts should be made to transfer optically the interference distance to the wires, no longer in contact with the apparatus.

(3) To use a gauge with plane-parallel end surfaces instead of spherical ones in order to profit by the high precision of calibration of a gauge with plane ends in comparison with the calibration of a gauge with spherical ends.

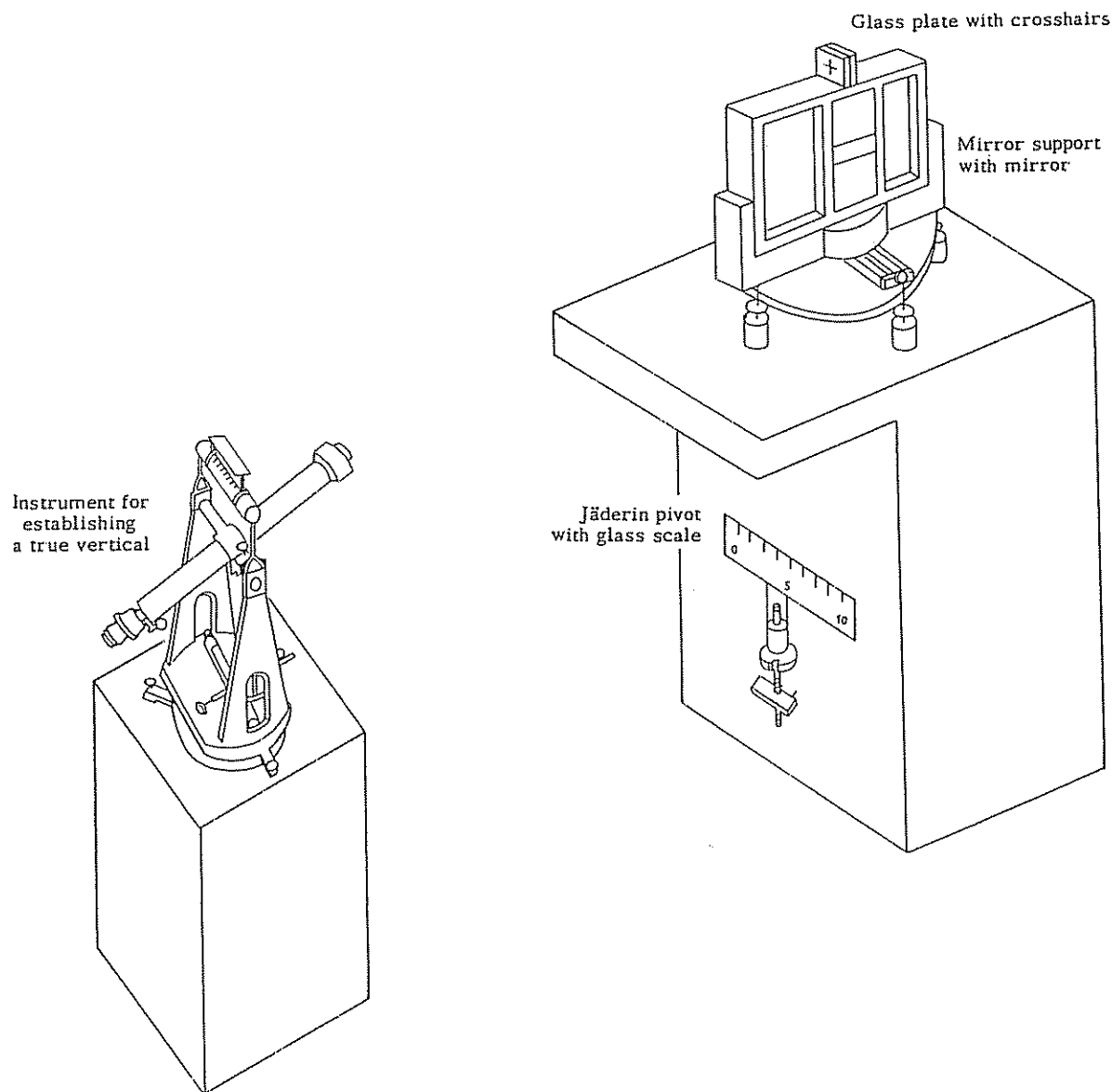


Figure 15. Transfer of interference distance to measuring tape : diagram showing theodolite telescope method.

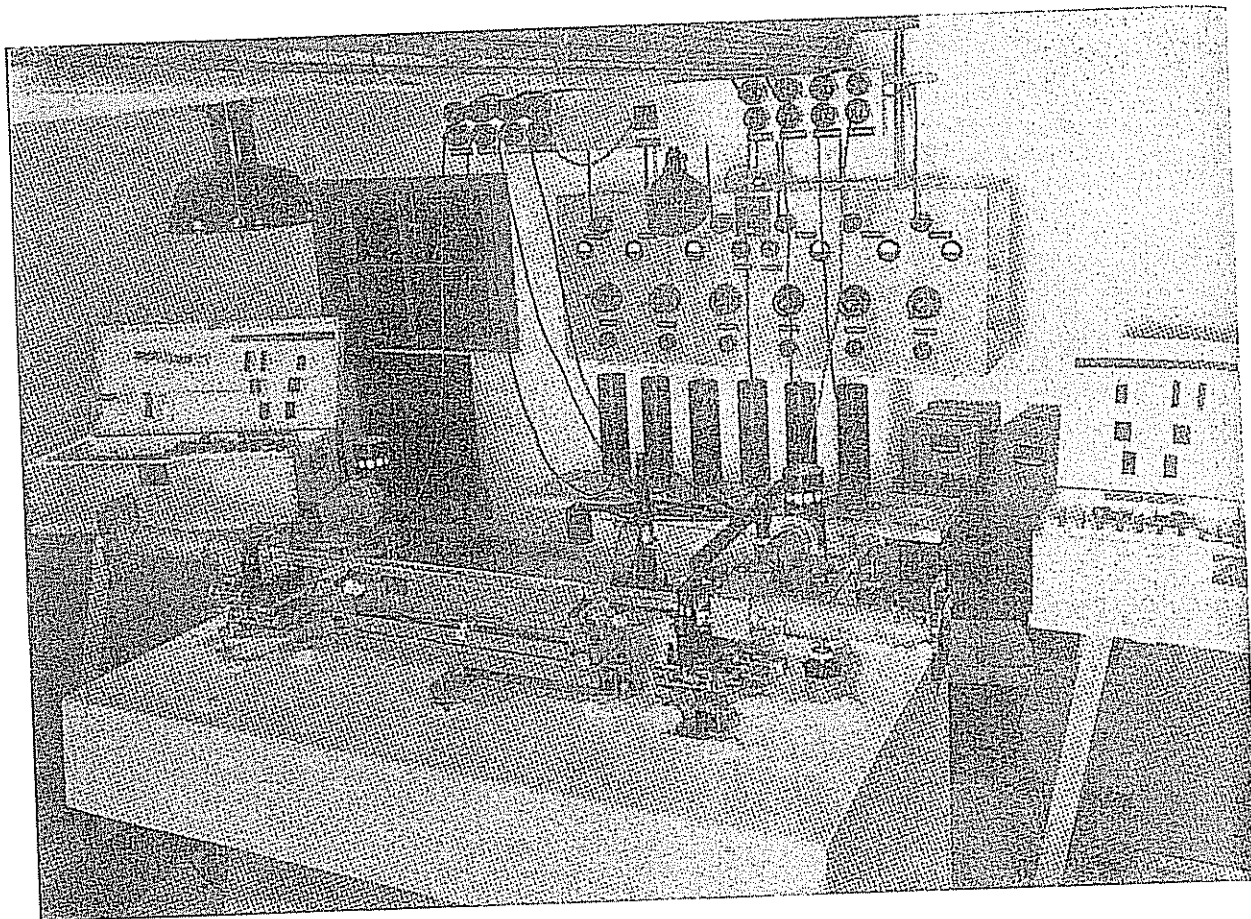


Figure 16. View of the one-metre base line and inserted quartz with plane-parallel terminal faces

*New mirror supports* (figure 13). The main idea in constructing new mirror supports was to mount the mirror on a double support, which can be tilted and rotated, like the transit telescope, in order to facilitate the adjustment of parallelism of the mirrors. Moreover, the bracket of the mirror support was arranged to glide on polished steel axes. Its bearings can be moved by a micrometric screw so that the mirrors maintain their parallel position while shifting. Finally, by means of a differential screw it is also possible to move the mirror support by minimal amounts of about  $1 \mu$  or less.

The compensator plates developed by Väisälä are no longer used as a device for measuring but only for determining how much the mirrors shift. Gradually resetting the mirrors enables the compensator plates to be gradually adjusted to their normal position (perpendicular to the optical axis) and subsequently to be completely removed without losing the interference image in the telescope.

*Transfer of the interference distance to the wire or measuring tape.* At first it was intended to adopt the idea of Watanabe and Imaizumi, who constructed the body of the mirror in such a way that it became transparent in a vertical as well as a horizontal direction.

This made it possible to project a collimation mark from the upper surface of the mirror by means of an optical system to the wire stretched below the whole device, without in any way touching the apparatus. In practice, applying this method caused certain difficulties, since the mirror had to be turned 180 degrees after the first series of readings in order to eliminate systematic errors, making it technically impossible to observe exactly the same direction of projection. Therefore two other ideas have been carried out.

(1) A small glass cylinder with a spherical terminal face was pushed towards the centre of the mirror until optical contact was reached. Then a collimating mark was transferred to the wire by vertical optical projection by means of a theodolite telescope with micrometer placed on the side. The same instrument was also used as a means for vertical projection with the second mirror surface at the end of the distance measurement. The space between collimating mark and touching point of the spherical terminal face could be determined in the laboratory with an accuracy of about 0.5 (figure 14).

(2) The second method was based on vertical projection to the wire of a mark located on the mirror by means of a theodolite telescope with micrometer.

aced to one side at a distance of about two to six metres, with its aiming axis perpendicular to the finishing line of the base. The wire stretched below the apparatus did not touch the measuring device at any point. Alternatively, a measuring bolt, located on the pillar below the apparatus, was observed in its position with reference to the mirror support and used for wire calibration only after having performed the interference measurement. The horizontal axis of the instrument was placed vertically in the centre between reading-off mark and pivot or graduation scale, so that the angles of elevation and depression were equivalent, which did away with the necessity of changing the eye-lens slide to obtain a better definition of the image (figure 15).

With a distance of about two metres an angular change of one second corresponds to 0.01 millimetre. This is a sufficiently high degree of accuracy for practical requirements, since fractions of a second may also be observed.

*The quartz metre with parallel end surfaces for determination of the one-metre base line.* In order to determine the one-metre base line, Väisälä used a quartz metre with spherical end surfaces, one end touching one of the mirrors in optical contact, the other a small distance from the mirror's plane, the magnitude of the distance being subsequently determined by means of Newton's rings. For greater precision, however, it seemed more desirable to replace this metre bar by another with two plane-parallel ends. In this case there had to be a small air gap on both ends between bar and mirror plane, to prevent direct contact. Both these distances

Angewandte Geodäsie in Frankfurt. The apparatus is currently used—even in the open air under unfavourable conditions—to calibrate distances of twenty-four,

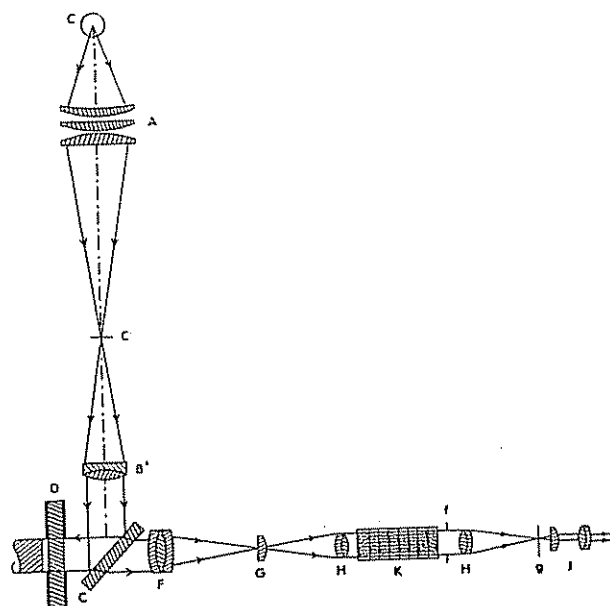


Figure 17. Optical arrangement for observing and photographing Lehmann's bands

C Plane-parallel, unsilvered glass plate; C' Slit diaphragm; K Direct-vision prism; E Quartz with plane-parallel faces; D Mirror, unsilvered in centre.

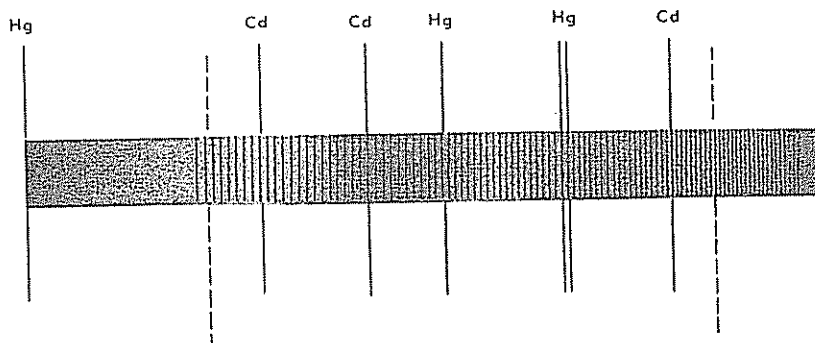


Figure 18.

*Lehmann's bands and the spectral lines (mercury and cadmium)*

The wave lengths of the mercury and cadmium spectral lines provide a scale for determining the distance of the quartz from the mirror, that is, the thickness of the air gap. The distance is a function of the number of Lehmann bands between any two spectral lines whose wave lengths are known.

are most favourably determined by means of Lehmann's interference bands, but Haidinger's rings may also be used for this purpose (figures 16 to 19).

The interference comparator, the improvements of which are described above, has been in use since 1938, formerly at the Reichsamt für Landesaufnahme (Reich Survey Office) and after the war at the Institut für

twenty-five and fifty metres. A distance of 100 metres has already been successfully measured with this device. The final step—determining the length of the quartz metre in lengths of light waves also—is in preparation. As soon as the necessary supplementary equipment to this apparatus is installed, it will be possible to define distances directly in light wave-lengths.

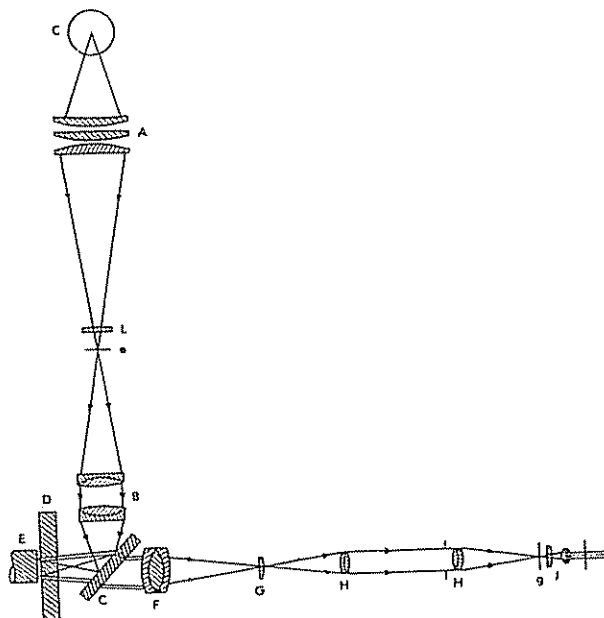


Figure 19. Optical arrangement for the observation and measurement of Haidinger's rings

The diameter of the Haidinger rings for given wave lengths is a function of the thickness of the air gap.

Assuming the range limit of this procedure to be about 400 metres in middle latitudes, a doubling of the distance might be obtained without particular difficulty, as described in the beginning of this paper. The experiments to reach 100 metres having met with no difficulties in spite of very unfavourable conditions on the Institute's own ground, there is good reason to think that a distance of 400 metres would not cause great difficulties either. Should these suppositions prove to be incorrect, it would be necessary to begin with the doubling procedure, mentioned above, at a distance of 200 metres, and subsequently to determine the distance of about 800 to 1,000 metres by repeating this procedure four times.

Summing up, I should like to emphasize that I am against remeasuring base lines for the purpose of scale verification. Such measurements undoubtedly are of a certain historical interest, but would hardly ever attain the objective envisaged because of uncontrollable errors in the base expansion figures. It would certainly be preferable to use Bergstrand's geodimeter for checking distances up to a maximum of forty kilometres. Under certain circumstances it might be advisable to compare the reference base lines existing in different countries by means of the Väisälä interference comparator or another apparatus suitable for base measurements.

## How to Organise a Magnetic Land Survey, Illustrated by the Example of India

by

Professor Richard Bock

A detailed survey of the magnetic conditions existing in a large country like India requires: (a) one main observatory in the middle of the area (figure 20); (b) three secondary observatories, located (i) in the north-east, (ii) in the south (Kodaikanal could be developed), and (iii) near Bombay (Alibag could be charged with these tasks); and (c) four auxiliary observatories, two of them in the north-west and two in the south-east.

Since the temporal variations of the magnetic elements have to be applied chiefly for reduction of field surveys, the distance between register stations should not exceed 700 kilometres. The speed of erection of an Askania variograph makes it possible to record the magnetic variations in the centre of the survey area concerned, rendering it superfluous to construct observatory buildings which will not cause any disturbance in the magnetic field. The uncertainty of the variations in basic values pertaining to the registration elements, however, necessitates permanent control measurements at the recording station.

The distance of about 700 kilometres has purposely been chosen, a distance of considerable length. It is advisable, therefore, to provide for registration in the survey areas, particularly if it is impossible immediately to carry out a programme covering the whole of the territory.

The following instruments would be appropriate for equipment at the different observatories:

### Main observatory (1):

#### Recording instruments:

- Askania variograph
- Eschenhagen-Schmidt or La Cour recorder
- High-speed Schmidt-La Cour recorder
- Askania teleregistration device
- $\frac{dx}{dt}$ ,  $\frac{dy}{dt}$  and  $\frac{dz}{dt}$  by induction

#### Absolute measuring instruments:

- Large Askania standard magnetic theodolite or Schmidt type with all accessories (such as length standard)
- Oscillation box with recorder (accessories: standard inertia bars)
- Simple station theodolite
- Large earth inductor with galvanometer
- Two sets of quartz horizontal intensity variometers by La Cour<sup>14</sup> (three pieces each)
- Two vertical intensity variometers by La Cour
- Two field balances of Schmidt type

<sup>14</sup> The Askania Company names its equivalent construction HTM.



- h) Two universal torsion magnetometers of the Askania Company as soon as construction is completed by that company<sup>15</sup>
- i) One complete portable magnetic theodolite with socket earth inductor

#### Secondary observatory (3):

Recording instruments:

- a) Askania variograph
  - b) Recorder by Eschenhagen-Schmidt or La Cour
- For checking the basic values (so-called absolute measurements):

- a) Simple station theodolite
- b) Oscillation box with recorder
- c) Earth inductor with galvanometer
- d) Two sets of quartz horizontal intensity variometers by La Cour
- e) Two vertical intensity variometers by La Cour
- f) One universal torsion magnetometer of the Askania Company, as soon as construction is completed

#### Auxiliary observatory (4):

Recorders:

- (a) Askania variograph

For checking the basic values:

- (a) One set of quartz horizontal intensity variometers by La Cour
- (b) One vertical intensity variometer by La Cour
- (c) One universal torsion magnetometer of the Askania Company, as soon as construction is completed

With its instruments (standard magnetic theodolite, oscillation box with recorder, and large earth inductor with galvanometer) the main observatory will be in a position to determine independently the absolute quantities of the magnetic elements. It may determine the basic values of the registrations by means of simpler observations (with oscillation box with recorder, simple station theodolite, and large earth inductor with galvanometer), the basic values of which—supposed to be constant—will result from observations by means of the standard magnetic theodolite and the oscillation box with recorder.

One set of quartz horizontal intensity variometers and one vertical intensity variometer are provided in order also to observe the course of the basic values between the observations made with the oscillation box with recorder and the simple station theodolite.

By means of the second set of quartz horizontal intensity variometers and the other vertical intensity variometers, the basic values can be transferred to the remaining seven observatories planned within the territory. This transfer can be effected by courier or by mail. Moreover, these instruments may be used to establish connexions with observatories located in neighbouring countries as well as in Europe, for which a well-organized mail service would be sufficient (the

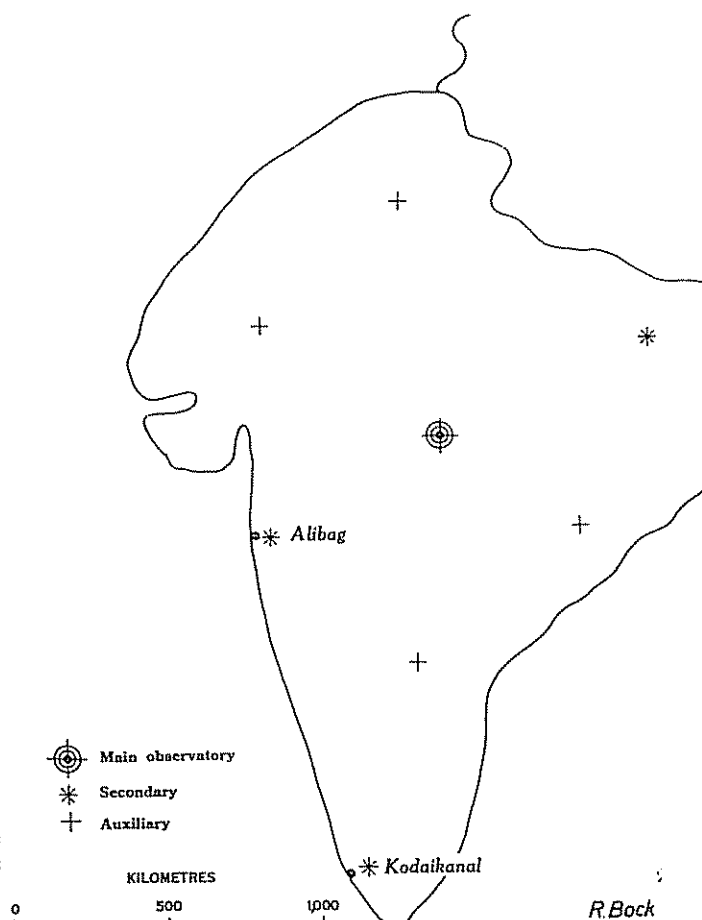


Figure 20. Suggested location of observatories in India

Danish observatory at Rude Skov is able to make arrangements for supplies of quartz horizontal intensity variometers, vertical intensity variometers, and recording devices by La Cour).

As soon as they are available the universal torsion magnetometers will considerably facilitate observatory and field measurements.

By means of the portable magnetic theodolite, main survey points are to be established between observatories, frequently connected with local variometer measurements, for example, by Schmidt field balances.

It is suggested that three installations of various kinds—such as an Askania variograph, a recorder and a teleregistration device—be established for recording so that there will be no likelihood of a deficiency.

Short-period variations, being more and more included in the general programme, might be recorded by installations of instruments as indicated in (c) and (e) of the first group.

The three secondary observatories will have simpler equipment. They will obtain their fundamental values from the main observatory by shipment of one set of quartz horizontal intensity variometers and one vertical intensity variometer and will determine the

<sup>15</sup> Or vertical intensity torsion variometers of the Askania Company.



basic values of their registrations. Intermediate values will be obtained by observations made with one set of quartz horizontal intensity variometers and one vertical intensity variometer remaining in the observatory.

The four auxiliary observatories will have only limited equipment. They will frequently obtain their fundamental values from the main or secondary observatories by means of their transfer instruments.

Two additional portable magnetic theodolites provided with socket earth inductors, to which a permanent location cannot be assigned, would be necessary for establishing main intermediate points. Between these

the dense network survey, required for subsoil research, might be established by means of either (a) simple declination theodolites, quartz horizontal intensity variometers or the HTM type (to be fitted upon the declination theodolite), and vertical intensity variometers or Schmidt field balances, or (b) universal torsion magnetometer instruments as soon as they are ready for delivery. Each set of field equipment should include a parasol and a tent.

The cost of the instrumental equipment may be estimated. However, the total cost of installation, including buildings, will largely depend on local conditions. Moreover, it should be taken into consideration whether qualified personnel will be available

## Suggestions relating to Photogrammetric Surveying of Average Accuracy and Mapping on Scales of 1:50,000 and 1:100,000

by

Dr. Rudolf Foerstner  
Institut für Angewandte Geodäsie

### MAP SCALES

When new maps are prepared in a country hitherto not covered, or only partially covered, by a survey one must first be quite clear as to the features to be shown. This consideration leads to the choice of the appropriate scale.

For the most part, it will be evident that certain areas are of particular importance whereas others are less so and therefore it is difficult to indicate a uniform scale. The second question then arises: Should a uniform scale be maintained or should the map series be prepared in such a way that certain regions will have a larger or smaller scale?

If it is decided to have different scales, then it must be determined whether subsequently a map series is to be prepared on a uniform scale for the whole territory, or whether the small-scale maps of those areas available on a larger-scale map shall be derived from this scale by generalization.

In this case the map scales of 1:50,000 or 1:100,000 are already fixed. If area A is to be mapped at 1:50,000 and area B at 1:100,000, then the following possibilities arise:

- (1) Area A on a scale of 1:50,000, area B on 1:100,000.
- (2) Area A on 1:50,000, area B on 1:100,000. For area A, however, an additional map on a scale of 1:100,000 is prepared by generalization from the 1:50,000 map. Thus, a uniform map on a scale of 1:100,000 is available covering the whole territory.
- (3) Areas A and B are mapped on a 1:50,000 scale. For area B the 1:100,000 map is derived from the 1:50,000 scale map. Thus, a uniform map on a scale of 1:50,000 is available covering the whole territory.

The choice of one of these possibilities is important for flight planning. Without particulars as to pur-

pose and design of the maps one cannot judge which method would be preferable. This decision would be still more difficult if even a scale of 1:200,000 should, in the first place, prove to be sufficient for certain regions.

### ACCURACY OF PHOTOGRAMMETRIC SURVEY

With precision plotting apparatus an average accuracy of position will be obtained amounting to  $\pm 30$  to  $40 \mu$  in machine scale (model scale). Precision plotting machines admit partial magnification of the original picture up to 2:1. So the average accuracy of position is  $\pm 15$  to  $20 \mu$  measured in image scale.

The average accuracy of elevation of prominent points amounts to 0.1 per thousand approximately of the flight altitude. For the project envisaged, the utmost accuracy is not required. Therefore, great average errors may occur. The following values may be considered sufficient:

Accuracy of position:

- 1:50,000 :  $\pm 35 \mu$  (measured in image scale)
- 1:100,000 :  $\pm 55 \mu$  (measured in image scale)

Accuracy of elevation:

- 1:50,000 :  $\pm 0.35\%$  of flight altitude
- 1:100,000 :  $\pm 0.40\%$  of flight altitude

### ACCURACY OF THE MAP

Requirements as to accuracy of a map are different, in different cases. Unless the concept "average precision" is more clearly defined one only assume any reasonable value therefor. It is to be assumed that the amount of systematic error of lesser importance for the task described herein.

The average accuracy of position in a small-scale map is  $\pm 0.2$  millimetres. This corresponds ap-

ately to the accuracy of drawing. The average error in elevation pertaining to single points is about one-fifth of the accuracy of position. In most countries the average error in contour lines is a function of the slope, being about twice the average error in elevation for single points with a slope of 10 degrees.

#### Accuracy of position :

- ± 0.3 millimetres in map scale, which means :
- ± 15 metres on the ground with 1:50,000 scale
- ± 30 metres on the ground with 1:100,000 scale

#### Accuracy of elevation :

- ± 0.06 or 0.05 in map scale, which means :
- ± 3.0 metres on the ground with 1:50,000 scale
- ± 5.0 metres on the ground with 1:100,000 scale

#### SCALE OF THE IMAGE AND FLIGHT ALTITUDE

Considering the assumptions already mentioned, as to accuracy of position, the following image scales result : 1:400,000 for a map at 1:50,000; 1:550,000 for a map at 1:100,000. The following flight altitudes result if the assumptions as to accuracy of elevation prevail : 8,500 metres for a map at 1:50,000; 12,500 metres for a map at 1:100,000.

With a camera constant of  $f = 21$  centimetres (normal-angle lens), the following image scales correspond to these flight altitudes : 1:40,000 and 1:60,000. With a camera constant of  $f = 11.5$  centimetres (wide-angle lens), the following image scales correspond to these flight altitudes : 1:75,000 and 1:110,000.

On the given suppositions the accuracy of elevation will be decisive. It is suggested, therefore, that a wide-angle camera be used for the following reasons : (a) a smaller scale of image can be chosen, thus reducing the number of stereograms and control points. This is of great importance since the control points are determined by triangulation from photographs. (b) With wide-angle photographs it is easier to observe the accuracy required in elevation. Therefore, simpler plotting instruments may be used for plotting as occasion may arise. The following scales of photography are suggested : 1:70,000 for the map at 1:50,000, and 1:100,000 for the map at 1:100,000.

For a camera 18×18 centimetres, with a camera constant of  $f = 11.5$  centimetres, the corresponding flight altitudes are :

- $h = 8,000$  metres for a map at 1:50,000
- $h = 11,500$  metres for a map at 1:100,000

It is supposed that the aircraft used has a minimum ceiling of 12,000 metres and that the climatic conditions of the country will admit flights of long duration at that altitude.

#### DETERMINATION OF CONTROL POINTS

If the scale of the map is 1:50,000, an area of 1,000 × 1,000 kilometres, that is, one million square kilometres, is covered by 20,000 stereograms, approximately. For stereoscopic measurement a total of 30,000

control points will be necessary, or one control point for every thirty-five square kilometres.

When thirty to thirty-five photographs are compiled for each triangulation strip in order to determine the control points, this strip will have a length of about 175 kilometres. A territory of one million square kilometres will therefore be covered by 600 triangulation strips, approximately.

If four control points are given for the first and the last stereograms, then about 1,400 control points are needed, provided that these points may be partially used for adjoining strips.

With east-west flight lines these control points are located approximately on lines extending in a north-south direction. Therefore they may likewise be determined by triangulation from photographs. In order to avoid systematic displacements of these strips they should not be too long or should be secured by one to three intercalating points. That means that a control point should be located every forty to fifty kilometres along these lines. If single one-sided bows are also expected in the east-west strips, these errors may likewise be eliminated by additional control points in certain strips. Then strip connexions are used for the remaining strips, thus reducing the number of control points to about 450.

Disregarding unimportant systematic remainders these bows of the east-west strips may also be eliminated from the border connexion alone. Thereby control points are reduced along these flight strips in an east-west direction. While observing equal accuracy it is possible, therefore, to extend the length of strips and to include about fifty stereograms in one triangulation strip. Then the flight strips have a length of about 250 kilometres, and twenty-five junction points require four pass points each. Moreover, about 100 control points are necessary for twenty north-south strips (distance between points forty kilometres approximately). So one control point will be sufficient for about every 5,000 square kilometres. The north-south strips may be broken at various places provided that they may be reconstituted by strip portions. One advantage of this procedure is that the location of these points may be chosen within relatively wide limits.

If the scale of the map is 1:100,000, an area of 1,000 × 1,000 kilometres, that is, one million square kilometres, is covered by about 10,000 stereograms. For stereoscopic measurement a total of 15,000 control points will be required, or one control point for every sixty-five square kilometres. When thirty to thirty-five photographs are included in one triangulation strip for determination of control points, this strip will have a length of about 250 kilometres.

An area of one million square kilometres is then covered by about 300 triangulation strips. If four control points are given in the first and final stereograms of each strip, then about 700 control points will be necessary, provided that these control points may partially be used for adjoining strips. These control points may be determined likewise by triangulation from photographs. On the same suppositions as with

## Establishing a Land Register (Cadastre)

by

Dr. Friedrich Kurandt  
President of the Co-operative Committee  
of the Survey Offices of the German States

Every discussion about a register of landed property could begin with the reminder of Benzenberg: "The essential feature of the land register is that it be completed."<sup>1</sup> In principle, however, human achievements are already out of date at the moment of their completion, for during the work social and economic changes as well as new ideas and views can no longer be taken into account. A contrary approach would endanger the uniformity of the project.

Experience has shown that the primary difficulty encountered in establishing a register of landed property is lack of the necessary financial means, which can only be obtained if the expenses involved are in a reasonable proportion to the benefit foreseen in the far future. Unfortunately, technical perfection, a consideration to which a technician is often inclined to subordinate financial considerations, prevents the establishment of a land register from being economical.

### PURPOSE OF THE REGISTER

The success of any project depends on the number of purposes it can fulfil. The older land registers, originally set up for the sole purpose of facilitating taxation of land, were soon used for administrative, economic and other purposes. For maximum usefulness, a land register should, from the start, be designed for as many purposes as may be required and, in the meanwhile, duplication of surveying work with that of other cartographic projects should be avoided. In most cases, the tasks to be carried out have to conform to terms prescribed by law—in particular, legislation dealing with landed property and taxes.

Among the important requirements to satisfy, a modern land register must provide basic documents for the following purposes:

- (1) Land taxation;
- (2) Designation of lots and blocks in juridical registers (proprietary register, mortgage register, and so on) and the protection of landed property;
- (3) Public planning (town and country planning, communication and traffic planning, construction planning);
- (4) Economic purposes (loans, agricultural and forestry planning, pipelines and hydrological, geological and other technical purposes);
- (5) Preparation and revision of topographical maps;
- (6) Statistics, science and research.

### GENERAL ARRANGEMENT

The quality of a land register is judged not only by its technical arrangement but also by its ability

<sup>1</sup> Benzenberg, *Über das Kataster*, vol. I (Bonn, 1818), page 464.

to meet the various requirements in order of urgency. In view of the great number of items to be recorded—as shown by the mere fact that in many advanced countries the number of real estate parcels exceeds the number of people—a land register must be planned with emphasis on simplicity and clearness. Furthermore, it must also be practical from the user's point of view and show only those features which remain unchanged for a sufficiently long period of time. Careful consideration must be given to the need for maintaining the register permanently up to date. Finally, the arrangements should have some flexibility to avoid frequent modifications due to changing conditions which cannot continuously be incorporated; in other words, it must be possible to review the arrangement from time to time.

This objective can be achieved by dividing the entries into two categories: the first to include items remaining valid for a long period of time due to the invariability of natural factors—especially physico-chemical factors—and the second, items subject to modification owing to changing economic and social conditions.

### TERMINOLOGY

As the requirements of cadastral work are largely prescribed by law, the choice of cadastral terms cannot be entirely free. Nevertheless, difficulties often occur when uniformity of terminology is not achieved in the different laws. For instance, the German word *Grundstück* has various meanings. Such a confusion can be avoided if, at the outset, each term is clearly defined.

### CADASTRAL UNITS

As defined by its name, a register of landed property records and describes immovable items, in general rights to property, real estate parcels, and in most cases also the buildings thereon. A register for manifold uses records all landed properties without exception, including real estate exempted from tax and from land registration.

In a "cadastre" for tax purposes a cadastral unit corresponds to a taxable unit, called "lot" or "parcel" and therefore the term "lot cadastre" is sometimes used. During surveying, the area of the land as located in the field is recorded as a lot provided that it belongs to the same proprietor and has the same use. This delimitation of land according to its use is required for fiscal reasons as the tax rates are set according to land use, to simplify computation of yields. Unless the tax on land is based directly on the size of the lot—surface taxation has often been replaced by taxes on enterprises—the regulation that a cadastral unit comprise only one type of land use is no longer

the 1:50 000 map, the number of control points is reduced to 350, approximately.

If the bridges are used for adjustment and the triangulation strips extended to sixty photographs, that is, 350 kilometres, then a total of sixty-four control points will be necessary for sixteen nodal points. Moreover, eighty-four points must be added as required for shoring up the north-south strips, so that a total of 150 control points must be determined, that is, one control point for every 7,000 square kilometres. Here the control points may likewise be chosen within wide limits, particularly if the north-south strips are built up by strip portions overlapping at the zone of their separation points.

When selecting flight strips for determination of control points, one should use the existing geodetic triangulation network as far as possible in order to reduce field work. For the control points the accuracies indicated in the section on "Accuracy of the Map" are applicable as maximum errors.

#### PLOTTING INSTRUMENTS

For aerotriangulation, stereoscopic plotting instruments of first order are required. The stereograms mentioned in the preceding section must be supplemented by north-south strips consisting of 1,000 to 1,400 and 550 to 700 stereograms, respectively.

The plotting of single stereograms may be performed by second-order or third-order instruments. It may be assumed that the accuracy of horizontal location will be generally observed. For elevation measurements the accuracy values specified in the section on "Accuracy of Photogrammetric Survey" are valid.

Third-order plotting instruments are less expensive. Moreover, they only require one operator, in most cases. So far as they observe the accuracy required they may be used for plotting. Since orientation of all stereograms has been performed already for determination of control points by a first-order instrument, it is profitable for third-order instruments to take their orientation elements for relative orientation from aerotriangulation.

The second-order and even first-order instruments are of equal, perhaps even greater, economy for extensive surveys. With small-scale plotting, however, they are frequently attended by two operators. Because of the higher accuracy the image scale may be further reduced. But, with regard to the difficult identification of details, this is not advisable considering the fact that the saving of time is due to the determination of control points and orientation of stereograms. On the other hand, the continuity of operation is considerably increased by these instruments, thus essentially raising the superficial output.

#### TIME REQUIREMENTS

Based upon an aircraft speed of 260 kilometres per hour and including an allowance for climbing, the flights will require the following time (area covered: one million square kilometres):

1: 50,000 : 500 hours

1:100,000 : 350 hours

The number of hours required for departure from and return to the nearest airport is not included therein.

Assuming that the plotting machines work with a double shift of operators, seven hours each, a net total of 3,000 plotting hours result per year. With the triangulation from photographs, one stereogram is achieved per hour. At a rough calculation, the output per hour, measured in hectares, is one-thousandth of the scale number. In certain cases, this output will not be reached by a third-order instrument, whereas second-order or first-order instruments will exceed it because of their higher precision and the lesser accuracy required. It depends on the ratio of these outputs to the purchase price whether one kind of instrument or the other would be profitable.

With a surface of one million square kilometres the triangulation from photographs (without subsequent calculation) will take seven years for 1:70,000 scale of the photograph and 3.5 years for 1:100,000 scale of the photograph, when one instrument is used.

The measurement of one million square kilometres (without subsequent mapping) will take 500 years for a map scale of 1:50,000 and 250 years for a map scale of 1:100,000, when one first-order instrument or a second-order one is used. With a third-order instrument these numbers may increase accordingly.

#### PHOTOPLANS

Stereoscopic plottings may be replaced by photoplans in case the relative differences in elevation are smaller than one-thirtieth of the flight altitude (this means 250 metres difference in elevation with the 1:50,000 map and 400 metres difference in elevation for the 1:100,000 map), and no indication of height is required.

If the latter is not the case, the planimetry of the map may be obtained at least by drawing over rectified air photographs, whereas the contours only are to be measured by a stereoscopic plotting instrument. The overlap between aerial photographs should normally be 60 per cent.

If a trigonometric network with a distance of 5 to 60 kilometres (for 1:50,000) or 80 to 100 kilometres (for 1:100,000) is available, control points may be determined with sufficient accuracy by radial triangulation with the slotted template method, provided that no altimetry is required.

necessary. It is even detrimental, except in the case of large lots all parts of which are not put to use or not legally linked together. Today a lot or parcel of land is generally understood as a portion of the earth's surface bounded by a closed line and shown on the district map by a particular number. The lot is neither necessarily identical with the unit of land tax nor with landed property in judicial meaning—the unit used in juridical registers. The latter may consist of one lot, or of several lots; it may even comprise parcels of land quite separate from each other if they have the same legal status.

Although the cadastral unit can be defined by the boundary lines shown on the district map, an attempt should be made, whenever possible, to have the cadastral units coincide with a portion of land limited by natural boundaries. In countries possessing a property register, the regulations as to how lots can be formed are almost completely determined by the requirements of the property register, but it is always advisable to keep the number of lots as small as possible.

#### NUMBERING OF LOTS

A lot is designated by a particular number shown on the district map. Just as the name of a person distinguishes him from other people, the reference number of a lot represents a specific portion of the earth's surface with its extent and boundaries and serves to connect surveys and registers. Arabic figures are generally used.

The numbering system is arranged in each zone called zone of numeration. The zone coincides in general with a community, as fiscal and administrative requirements are that cadastral and juridical registers be established according to community divisions.

A numeration zone includes all the land pertaining to the area of the community. For historical reasons the boundaries of a community district may be irregular lines, and sometimes parts of lands of a community are located within the area of another community or extend into it like a tongue. Since it is not possible to represent coherently many land areas of odd form, often lying at a long distance from one another, cadastral offices sometimes establish for their own purposes and requirements special property districts differing from community districts and comprising rounded off areas of landed property closed with natural boundaries. In Germany such a cadastral district is called a *Gemarkung*; it is a district topographically comprising a single group of landed properties conveniently enclosed and easily identifiable in the field. Since it is advisable to limit a lot number to three figures as a maximum, it may be necessary to subdivide a *Gemarkung* into smaller numeration districts by topographic delimitations (fields, sections and so on).

For each cadastral zone the numbers of the lots begin with the figure 1 and continue regularly; thus, the last lot number also indicates the total number of lots existing in the zone. This total number can

be easily found on the map by following the direction in which the index number increases.

#### DESCRIPTION OF CADASTRAL UNITS

The manner of describing the details of cadastral units depends on their primary qualities considered from an economic point of view. The location of the land and the nature of soil are decisive factors as they determine the possibility of land use and consequently the yield of a landed property, likewise its value. Therefore the cadastre should generally record:

- (1) Number of cadastral units;
- (2) Location (street, number, field, or other reference);
- (3) Kind of land use (exploitation);
- (4) Nature of soil;
- (5) Quality of soil (agricultural properties);
- (6) Superficial contents;
- (7) Tax rate and, if necessary, the total tax (in a proper fiscal cadastre);
- (8) Proprietor and taxpayer, respectively.

#### APPRAISAL OF SOIL

In a fiscal cadastre certain groups of landed properties are set up according to fiscal indices or tax indices of these properties. Such a classification is not advisable for a many-purpose cadastre. Groups of properties can be distinguished according to the type of soil rent (rural or urban rents). The first group includes landed property used for agriculture, forestry, horticulture, viniculture, pisciculture or pond management—in brief, all landed property used for farming in the widest sense of the word, that is, real estate with rural rents. The second group comprises other landed property, particularly properties with buildings thereon, whether for residence, industry, communications or similar purposes; that is, real estate with urban rents.

The value of landed property for farming use depends primarily on soil quality, which has to be determined by an appraisal (classification of the soil). As a rule the appraisal itself is carried out in accordance with schedules established separately for the various types of cultivable land, at least separately for arable soil and meadow land. The standard values for these schedules are either absolute yield quantities, assessed for the different classes, or proportional numbers expressing what proportion the productivity of a land surface bears to that of a standard surface, the most productive usually bearing the standard value 100. The extensive differentiation of soil classes applied in earlier land taxation is not advisable, for it has been observed that yield often is more influenced by other factors such as relation to communications, type of soil or kind of culture than by quality of soil.

#### MAP OF SOIL VALUATION

The objective of soil appraisal is to provide a basis not only for a just tax assessment but also for a system

ic approach to soil use. In a modern system, not only the productivity of soil but also its condition and status of development are described. The result of such a "stock taking" of the soil can be used for advising on agricultural management and can save future local investigations. To exploit fully the data, it is necessary to record them on maps. Therefore a modern property cadastre involves a map of soil valuation. The design of such a map would have to conform to local requirements and traditions stressing either the nature or the quality of soil. Since the productivity of soil is essentially influenced by the topography, it will be necessary to consider also the third dimension, that is, elevation, which is likewise required for other purposes such as preparation and revision of topographic map series. These maps are greatly appreciated not only by advisory offices for agricultural management but also by other administrations, such as country planning and land authorities.

#### CONSTITUENTS

A cadastre is based on surveying data and cadastral documents and contains a descriptive part (books) and an illustrative part (maps). While a fiscal cadastre may be established eventually without maps, a cadastre for multiple purposes must have maps. The history of development of land registration in the past hundred years shows that the emphasis has continuously shifted in favour of maps and, at present, conditions are even exactly the reverse: the book might be overlooked in a many-purpose cadastre.

Considering the high cost of such a survey, it would be inappropriate to economize by limiting the work to what is strictly necessary for the cadastre itself. One must not underestimate the danger that surveying offices will prepare the cadastre according to their own requirements; this danger is greater now than in earlier times because then surveying offices were only charged with one part of the work while the other was controlled by fiscal authorities. A cadastre is not an end in itself. It can only satisfy the needs of the interested parties if the arrangements are sufficiently clear to enable users to find quickly the information they require without help from outside or from specialized knowledge. History also shows that the cadastre has gained a greater importance in the mortgage business and in economic studies only where a clear and up-to-date registration existed and that the money lent is repaid to a great extent through income from recording fees and fees for copies of documents.

In general, the descriptive part of the cadastre, the book series, is composed of two sections: a topographic register, listing cadastral units according to their numbers, and a subject register listing them according to property status or the index of proprietors contained in the juridical land register. In order to simplify book-keeping and to facilitate handling, these two sections are generally supplemented by a register of proprietors established on the basis of the current numbers in the subject section, the alphabetical register of names and the register of building properties.

The topographic register is the most important part of the cadastre from the viewpoint of the survey offices. In Germany it is called *Flurbuch* and is usually bound in book form. Nowadays the other registers are in general kept in the form of a card index, which has greater advantages than a book.

The illustrative part of the cadastre, the map series, is always based upon surveying. The map is either prepared directly in the field (graphic cadastre) or compiled indirectly in the office on the basis of field measurements (numerical cadastre). The large-scale cadastral map, called *Flurkarte* in Germany, contains contour lines and other topographical data in addition to the information required for maintenance of the property cadastre in order to satisfy technical, economic and planning requirements. For the same reason, cadastral maps in Germany are now prepared in general as *Rahmenkarten* (framework maps), although the *Inselkarte* (insular map) corresponding to cadastral districts could better serve cadastral interests which, in this case, are subordinated to the general interest. The scale of cadastral maps, to be decided in taking into account the distribution of properties and the value of real estate, should be kept as small as possible for economy.

The preparation of framework maps is based on a uniform network of co-ordinates which makes it possible to compile correctly both special and index maps from a single sheet map. In Germany, the preparation of cadastral index maps follows the specifications of the *Deutsche Grundkarte* (German base map)—scale 1:5,000. Reductions of the cadastral map on the scale 1:5,000 constitute also archival copies for the *Landesvermessungsämter* (State survey offices). Moreover, the 1:5,000 index map serves as the base for the map of soil valuation mentioned above.

#### SURVEYING METHODS

Not technical perfection but economic considerations should determine the arrangement and proper surveying methods of a cadastre which must satisfy various requirements, not only of the present but also of the near future. The cadastral work should be planned in accordance with the financial means available, the time-limit for completing the work and the qualifications of personnel. Nowadays, provision of appropriate instruments causes almost no difficulties. In an important project it is always advisable to use modern instruments, with which better and quicker work can be done. Furthermore, good planning is important—sometimes even of greater importance than the surveying method itself.

When deciding on a technical procedure one should in principle consider all possible methods instead of sticking to a particular one as was generally the case in earlier times. It may be of advantage to combine different procedures and to set up new methods, but usually the technician timidly sticks to examples given in the instructions. This trend should be opposed; modern instructions should admit some free play. However, modification for the better is only possible



with a team of skilled and experienced personnel supervised by a person well qualified both scientifically and practically.

#### PERMISSIBLE ERRORS

The main purpose in limiting permissible errors is to ensure careful measurement; these limits should not be set up too narrowly, otherwise the surveying work cannot be carried out economically. Negligent work makes it necessary to do the work over again. In spite of the greatest care all measurements yield only approximate values. It is necessary to know beforehand the degree of accuracy obtainable through various methods in order to fix the particular limits for permissible errors in terms of general technical efficiency, considering not merely one factor such as terrain conditions or soil classification. The procedure applied in each particular case should subsequently be reviewed.

#### NETWORK OF TRIANGULATION STATIONS

A modern cadastral survey is always based upon a good trigonometric network. New developments in triangulation techniques<sup>2</sup> will, in the near future, bring about a great revolution in geodetic triangulation but it will not affect proper cadastral triangulation much. In most cases the trigonometric network alone is not sufficient for a detailed surveying, further stations (secondary stations, polygon points, control points, etc.) being required. Probably electronic instruments<sup>2</sup> for measuring short distances (geodimeters) will soon help to accelerate the establishment of points, but at present a trigonometric determination of stations without measuring the polygon sides can give a considerable increase in efficiency and often also in precision. The introduction of innovations in triangulation will not lead to any great economy in cadastral work as the amount of geodetic operations is too small. Important savings may be obtained in detailed surveying, the so-called *Stückvermessung* comprising about 75 per cent of the field work. It is also important to secure durable bench-marks and fix stations for the reason that the possibility of modifying and improving a surveying project depends upon the existence of a good dense net of triangulation. If all future surveys were to be connected with the triangulation network, then a mapping project would continuously be improved by resurveys instead of deteriorating as in the past. Therefore, resurveying should be carried out with the utmost care and greater precision.

#### DETAILED SURVEYING

As in the case of the scale of the map, the detailed surveying depends essentially upon the soil value, the distribution of property and the shape of the ground to be surveyed. Moreover, it is largely influenced by

<sup>2</sup> E. Gigas, "Ziele und moderne Arbeitsweisen der Grossraumgeodäsie" (Objectives and Modern Methods of Continental Geodesy), *Zeitschrift für Vermessungswesen*, page 329.

the kind of marks showing the boundaries of properties, which vary either with the types of soil use or with local custom. It may be useful to distinguish between permanent boundaries and somewhat variable ones. Permanent boundaries are defined by line form constructions (walls, hedges, fences, and so on) or by single points represented by prominent objects (such as corners, monuments, trees, stand pipes). To avoid future disputes all boundaries should be fixed and eventually marked with the participation of all the proprietors concerned before cadastral surveying begins. Such a procedure increases considerably the costs of the survey, but the cadastre thus established becomes an authoritative document for property definition. Moreover, in view of the increasing mechanization of farming it is advisable to secure boundary stones by means of subterranean reference marks.

#### GRAPHICAL COMPUTATION

It was believed that the security of landed property required delimitation of boundaries with a degree of accuracy to one centimetre. This problem is not only a matter of law and engineering<sup>3</sup> but in the last resort a social problem and a question of ethics. However, its accuracy should not generally be defined as the highest obtainable but rather precision which can satisfy practical requirements. Moreover, the argument that precise numbers are necessary to determine surface areas of landed property is not always acceptable. Experience has proved that, in general, graphical determination of surface areas is more than sufficient, as economic factors are of much greater importance for evaluation of real estate. Moreover, a change seems to have begun in survey computation leading to increased application of graphical methods because of their economy in comparison with procedures now preferred. Wherever this method is adequate, one should refrain from computing the co-ordinate for the different boundary corners although it is theoretically possible to do so. These computations may be performed at a later date when necessary. But it must always be borne in mind that the correct relative position of points—an essential matter in cadastral survey—must be calculated.

#### PROCEDURES

Surveying methods in current work—plane table method, tachymetric method, polar method, intersection method, classic (linear, rectangular) methods and photogrammetry—being well known, only brief remarks will be made on the last two methods. In Germany the classical method has replaced all other customary procedures during the past century, because of its technical advantages. With this method the accuracy of relative position of neighbouring points is always obtained and can be checked by computation. The method is easy to learn and to apply, but its disadvantages are high cost, length of time and a certain

<sup>3</sup> F. Kurandt, "Vom statistischen zum dynamischen Kataster" (From a Static to a Dynamic Cadastre), *Zeitschrift für Vermessungswesen*, page 305.

dependence upon the reliability of the operators. Moreover, the recording of numerical notes on field sketches presents certain difficulties.

After the invention of photography, research began in applying photography to surveying. To a large extent this procedure renders the surveying work independent of the personal reliability of the observer and of seasonal and meteorological conditions. The development of aviation, making it possible to obtain pictures of any terrain required for economical surveying, has led to a wide application of photogrammetric methods, particularly in the preparation and revision of topographic maps. Nevertheless, the possibility of applying such techniques to cadastral surveys was still debatable until recently, as difficulties were encountered in obtaining the same degree of precision as with the classical method. Photogrammetry can, in principle, observe the limits of permissible error prescribed, but in practice experiments demonstrated another unexpected fact: aerial photogrammetry yields a uniform accuracy in locations of all points, thus differing from the laws of error propa-

gation existing in terrestrial methods. It results that, with distances between points located close together, the usual limits of permissible error cannot be observed by photogrammetry, which therefore cannot be applied to surveying dense subdivisions, particularly towns and their border areas. In less developed areas, for which the utmost precision is not required, a method which gives approximate values increases the economy of the work. It may be assumed finally that, in the near future, photogrammetry will undoubtedly surpass all traditional methods of surveying.

#### CONCLUSION

The question of organizing land registers within a political system is not dealt with in this paper as it depends on the administrative and economic organization of the country concerned. On the basis of experience in Germany it can be said that all the surveying work will suffer if geodetic measurements and cadastral surveys are carried out independently of each other.

### Research Institute or Committee and Common International Research

by  
*Dr. Erwin Gigas*

The establishment of a central research institute will certainly entail difficulties. Some years ago there were similar aspirations in the field of photogrammetry, but all negotiations between the interested European nations seemed to break down because of the demand for the creation of a central institute for photogrammetric research. Negotiations were set going anew, however, and met with marked success as soon as it was agreed to establish only a central committee for the direction of research activities, involving hardly any expenses. Thus it was only necessary to face the problem of winning the co-operation of the different nations who were willing to make available their own research institutes for the common purpose. In my opinion, therefore, the request submitted by Burma in item 7 (iii) would be best complied with by applying a similar method.

A central research institute would entail immense expense in purchasing all the different equipment of modern geodesy in order to be able to compare them.

On the other hand, the aim under consideration may certainly be attained with a minimum of cost by establishing a committee of experts, well versed in geodesy, who will endeavour to win the co-operation of nations with extensive experience, possibly through the intermediary of the United Nations.

Such a committee might be composed of about ten to fifteen persons who, because of their international acquaintance, would be in a position to decide very quickly in which country a special problem had been successfully dealt with. Thus, if a question concerning Shoran trilateration should arise this committee would perhaps consult the United States, Canada and Australia. For a question concerning distance measurement by means of high-frequency modulated light waves, however, Sweden and Germany should be consulted. By evaluating the different opinions this committee would obtain very reliable results in applying this procedure.



## COMMUNICATION RECEIVED FROM THE DELEGATION OF THE NETHERLANDS

by

*Dr. W. Schermerhorn*

*Dean, International Training Centre for Aerial Survey, Delft, Netherlands*

(The original text of this paper appeared as document E/CONF.18/A/L.7 and Add.1, under the title "Contribution to the Discussion of a Number of Agenda Items"; the addendum, which represented a correction, is incorporated in the text)

### SMALL-SCALE PHOTOGRAPHIC COVERAGE

It is assumed that rather large areas are considered and that the scale of the maps will be 1:100,000, the largest scale involved being one inch to the mile or 1:50,000. Aerial photography suitable for the construction of maps on this scale would, it is considered, require radar-controlled, high-altitude vertical photography on a scale of 1:60,000 or smaller.

In the past the scale of photography has been in many cases 1:50,000, 1:40,000 and even larger. Sometimes these rather large scales have been used because the same photographs have also been used for other purposes (inventory of natural resources or large-scale mapping of limited areas). Sometimes a lack of planes adapted for high-altitude flying has made the most suitable small scale for a map, 1:100,000, impossible.

A condition for the application of small-scale vertical photography is use of the most modern lenses. In view of the development of high-precision wide-angle lenses in several countries, all photography with old-fashioned Topogon-type lenses, such as the Metrogon, has to be rejected. In various countries modern types of lenses have become available: the American Planigon lens, the latest British Ross lens, the Wild Aviogon and the wide-angle equivalent of the Zeiss Topar, which will become available shortly. Therefore, no organization has any longer an excuse for use of old-fashioned lenses with less resolving power and with a noticeable loss of illumination of the image from the centre towards the corners. In particular, the equal density of the image over the whole surface of the wide-angle picture must be considered as a great advantage of the new wide-angle lenses compared with all existing old lenses. The possibility of the application of a smaller scale because of the better quality of the images will soon compensate for the cost of new cameras. In the case of public tenders the use of old Topogon-type lenses can be easily avoided by requiring that the radial distortion in any point of the image be 0.01 millimetres or less. Only the modern lenses mentioned above can fulfil this requirement.

Another requirement for an economic survey of large areas is the application of radar in one of its

modern forms: Shoran or Decca, for instance. Many of the countries in question are not completely covered by a primary triangulation net. Therefore, the only solution is either Shoran-controlled aerial photography or an aerial triangulation adjusted for scale and azimuth by means of base lines of about five kilometres with orientation obtained by solar observation. The absolute position of such a network is determined by the geographical co-ordinates of a few points derived from astronomical observations. For on a scale of 1:100,000 and in particular for 1:250,000 Shoran-controlled photography on a scale of 1:70,000 has proved to give sufficient accuracy. For 1:50,000 maps the Shoran co-ordinates can be improved by application of some high-precision aerial triangulation. In that case the value of the Shoran method is that systematic errors in aerial triangulation can be avoided. The role of aerial triangulation is to furnish corrections to the individual co-ordinates necessary because of the rather large accidental errors of the Shoran co-ordinates and to permit computation of heights.

In many Asiatic countries this small-scale photography for the production of new topographic maps has to be carried out perhaps only once in thirty-five years. After maps have once been made, revision will only be necessary in those regions where human activities through engineering and agricultural projects have caused changes of the earth's surface. For projects causing such changes, it will in future be normal that large-scale aerial photographs be made. These photographs, and many times also the maps on which the new projects are plotted, can be used for revision of the small-scale topographic map. With these data at hand it will not be necessary to repeat again the small-scale, high-altitude photography of such areas for a map of 1:100,000.

Therefore, for many countries it is a problem which has to be solved only once. If a topographic service can be provided once with a complete file of Shoran-controlled high-altitude photographs of first-class quality on a scale of about 1:60,000, it will have the basic material for construction of small-scale topographic maps.

If this is acceptable then the problem arises for many governments whether it will be worth while to establish a national service capable of carrying out this particular work. It will require highly specialized crews and special photographic planes for which there will be no use after the small-scale photography is finished. Even if radar equipment can be rented for one to two years, there are several countries where national technicians have so far had no experience in the use of this type of equipment.

Therefore, it seems advisable that governments should consider employing foreign organizations with experience in this kind of work and with the necessary equipment at their disposal. Whether the work should be done by a private enterprise or by the assistance of foreign government agencies which fulfil the requirements mentioned before is a separate problem. In making a decision, the advantages of having a national service capable of applying these modern methods must be taken into account.

A third solution would be to abandon this modern and most economical method and apply the methods known since 1935: a combination of ground control and aerial triangulation in the use of photographs on a larger scale. One consideration which can oblige government to apply this old method is that during two successive years it may not have the necessary funds for carrying out complete high-altitude radar-controlled aerial photography. If a government wishes to distribute the aerial photography of its territory over the whole period needed for construction of its topographic maps it will also be necessary to apply the old method because then the area to be photographed each year will in many cases be too small for use of an outside organization in an economical manner.

In some cases it will be possible to use, instead of vertical photography on a scale of 1:40,000 or larger for construction of a 1:100,000 map, the well-known method of a multiple camera, that is, one vertical camera and to the left and the right an oblique camera. Whether this has to be done with three wide-angle cameras so as to obtain the image of both horizons—as in the famous trimetrogon system—in order to determine the absolute orientation, or the combination of three standard cameras with a solar camera—as in a well-known Italian system—is a major question. The wide-angle in this case is advantageous only for simplification of the aerial triangulation. The area which can be mapped really is not much more than can be covered with three standard angle cameras. Whether the trimetrogon is to be preferred over a triple camera which requires a normal aerial triangulation improved by means of the image of the sun, is an important problem for this kind of aerial photography.

Another consideration in this respect is the possibility of direct plotting of the small-scale maps from the wing photographs. There are several solutions, one of which is to employ the Light Spot Projector, which is very much used for this purpose by the Royal Dutch Shell group.

Besides the well-known trimetrogon system, experiments should be carried out also with the Italian Santoni system in order to be able to judge this kind of photography, which can be very important for many types of small-scale topographic mapping in cases where no possibility exists for high-altitude radar-controlled photography.

#### IMPROVEMENT AND STANDARDIZATION OF CADASTRAL SURVEY METHODS

Until recently the general opinion has been that photogrammetry could not be used for cadastral surveys. The objections against it are as follows:

(1) Photogrammetry is a graphical method. The result is a line map. The highest precision obtainable is that of a draftsman producing a map on a certain scale.

(2) In areas with a high percentage of property boundaries which are invisible on the photographs, the photogrammetric method will not be economic because of the many ground surveys necessary for completion.

(3) The precision of photogrammetry is only sufficient for cadastral maps of areas with a low value of the ground.

Regarding these points recent developments in several countries in Europe (Austria, Germany, Netherlands, Switzerland) have proved that the possible precision of photogrammetric cadastral surveys was surprisingly high. A recent aerial test survey of a German area, in which previously a dense network of traverse and detail points had been established by terrestrial means, showed even the photogrammetric determination of points (with a mean square error of 9.5 centimetres) to be superior to the terrestrial determination of those points (with a mean square error of 10 to 13 centimetres).

This high accuracy can be obtained for well-defined points, sharply identifiable in the photographs, with analytical treatment of the measured machine co-ordinates. The boundary stones have to be white-washed, and other important points have to be marked on the ground (for instance with white discs with a diameter of twenty to thirty centimetres). Each model must be provided with four or five ground control points, at least one in each corner. As these points can normally also be used for the neighbouring models, the required number of ground control points is in reality about one or two per model. This means about one point per ten to forty hectares, depending on photo scale and size of the photographs. (This number should be compared with the number of trigonometric and traverse points necessary for a complete ground survey: one point per hectare or even one per 0.5 hectare.)

For properly selected photo scales (between 1:6,000 and 1:10,000), when modern cameras and modern plotting instruments are used, the mean square error in the planimetric co-ordinates of signal points surely will be less than 10 centimetres. The relative precision expressed by the mean square error in a distance between

two marked points is—owing to the correlation between the errors in the endpoints—even much better than the law of propagation of errors would indicate ( $< m_x \sqrt{2}$ ), for very short distances the lowest limit depending only on the accuracy with which the floating mark is made to coincide with the one in the spatial model.

Photogrammetry, applied in the above analytical way, can provide the complete geometrical framework (inside the net of control points) for completion of the ground survey. For this reason ground markers must be placed, before the aerial photography, in the neighbourhood of those details that will otherwise be invisible or poorly identifiable from the air. Recent publications have proved, furthermore, that photogrammetric methods under normal circumstances save about 40 per cent of the cost of the ground survey, including all costs of amortization of high-precision photogrammetric plotting instruments. Moreover, the saving in time, expressed in man-days, is 60 per cent or more.

Since modern practice—especially of the past two years—has shown that it is possible to carry out a photogrammetric cadastral survey with readings on the three co-ordinates of all prepared boundary stones and other marked points in centimetres, the first objection against photogrammetry no longer applies.

A remarkable fact, however, is that nowadays several cadastral authorities are willing to accept a high quality graphical map and do not insist any longer on the necessity of a numerical cadastre. The maintenance of a numerical cadastre over a period of 50 to 100 years, as has occurred in several European countries, has shown many complications and difficulties. These disadvantages, compared with the assumed advantages of the precision of figures—which in many cases is only hypothetical—lead to the fact that nowadays the value of a high quality large-scale map as such is more generally recognized than in the years between 1930 and 1940, when the first applications of photogrammetry to cadastral surveys were made. Such a map, however, simplifies the establishment of a new cadastral administration in many countries, and now it is more generally recognized that a good graphic cadastral map is wholly sufficient as a basis for the administration of property rights on parcels of land.

Regarding standardization, the Conference should be informed that one of the scientific commissions of the European Organization for Experimental Photogrammetric Research is in charge of a detailed study of the application of photogrammetry to large-scale precision surveys. One of the problems is to determine the

Table 3. Results of Experiments with Wild and Zeiss Cameras

Item	Netherlands	Switzerland	Austria		Germany		
			I	II	A	B	C
Photo scale	1:9,200	1:6,500	1:5,900	1:7,700	1:10,000	1:8,400	1:6,200
Camera	Wild RC7	Wild RC7	Wild RC7	Wild RC7	RMK 18/21	RMK 18/21	RMK 18/21
Size of photographs (centimetres)	14 × 14	14 × 14	14 × 14	14 × 14	18 × 18	18 × 18	18 × 18
Focal length (centimetres)	17	17	17	17	21	21	21
Net area per model (hectares)	40	20	16.5	28	80	60	35
Number of control points per model for absolute orientation	5	6	5 to 6	...	4 to 5	4 to 5	4 to 5
Plotting instrument	Wild A7	Wild A5	Wild A5	Wild A7	— Stereoplanigraph C8 —		
Mean square error (centimetres):							
Difference in position (vector) of marked points <sup>a</sup>	11.5	13.5	7.1	5.9	16.1	14.8	12.0
Ground determination <sup>b</sup>	2.5	5.3	3.8	4.0	13.0	13.0	10.0
Photogrammetric determination <sup>c</sup>	11.2	12.4	6.0	4.3	9.5	7.0	6.5
Photogrammetric determination of short distances <sup>d</sup>	4.5	9.0 <sup>e</sup>	4.3 <sup>f</sup>	...	8.8 <sup>g</sup>	8.8 <sup>g</sup>	7.4 <sup>g</sup>
Photogrammetric determination of greater distances <sup>h</sup>	4.5 to 10	—	—	...	9.9	10.4	8.1
Photogrammetric determination of heights of marked points	—	—	9.1	...	—	—	—
Graphical accuracy in position of marked points	22.1 <sup>i</sup>	16.3 <sup>j</sup>	—	...	17.6 <sup>j</sup>	25.8 <sup>j</sup>	—

Source: *Photogrammetria*, 1953/54 (Amsterdam), pages 45 to 47; *Schweizerische Zeitschrift für Vermessung und Kulturtechnik*, 1953 and No. 11, 1954 (Winterthur); *Festschrift, Eduard Dolezal zum neunzigsten Geburtstag gewidmet von seinen Freunden und Schülern* (Vienna, 1952).

Note: The extremely good values obtained in Austria are due to the fact that the experiments were carried out under ideal "laboratory" conditions (complete air-conditioning; repetition of measurements). All other tests were executed under normal working conditions. A remarkable difference between the results obtained with the latest instruments (Wild A7, Stereoplanigraph C8) and those obtained with the earlier instruments (Wild A5) is shown. Also, the German experiments show that when a good film camera (RMK 18/21) is used, the

results obtained are equivalent to those obtained with a glass plate camera (Wild RC7).

<sup>a</sup> Determined by ground and photogrammetric methods.

<sup>b</sup> Of the position of the control points plus check points.

<sup>c</sup> Derived values.

<sup>d</sup> Distances less than fifty metres.

<sup>e</sup> Compared with map on scale of 1:1,000.

<sup>f</sup> Less than twenty metres.

<sup>g</sup> Including errors of ground determination.

<sup>h</sup> Distances greater than fifty metres; including errors of ground determination.

<sup>i</sup> Map on scale of 1:2,000.

<sup>j</sup> Map on scale of 1:1,000.

ation between precision and scale of photographs. Another is the difference between film and plate cameras. A third concerns the precision of plotting topographic details which coincide with property boundaries. It is perhaps worthwhile to mention here the fact that Dutch Experiments have proved already that for property boundaries, formed by natural topographic features such as hedges and ditches, the error of identification made in the ground survey is much smaller than with photogrammetry plotting. In this respect the average surveyor overestimates the value of a ground survey.

Information can be given regarding experiments made with Wild RC7 cameras in Switzerland, Austria and the Netherlands and with Zeiss cameras with Topar lens in Germany (table 3).

#### SURVEYS WHICH FORM A PHYSICAL BACKGROUND FOR THE STUDY OF NATURAL RESOURCES

It is not intended to discuss here very thoroughly this complicated and specialized subject, but only to draw attention to the importance of aerial photography as one of the main tools for the study of natural resources. Although no complete study is possible without an adequate combination of ground survey and photo-interpretation, nowadays no well-organized exploration of natural resources is started without the use of aerial photographs. They form the real physical background for a study of natural resources in each country.

This fact was first recognized for geology. As mentioned in the introduction to the programme for session 2 of the Delft International Training Centre for Aerial Survey:

"... there has been some misunderstanding because photogeology was erroneously regarded as a substitute for the 'real thing': the immediate contact with nature. It should be emphasized, however, that it has never been the intention nor is it possible to substitute for traditional geological field work photogeological methods, but the latter is merely to assist and supplement the former. It is just another tool in the hands of geologists. In specially favourable cases, indeed, field work can be almost completely dispensed with and limited to the collection of rock samples and fossils or to the checking of certain doubtful structural features which are not clearly revealed in the aerial photographs."

What is said about photogeology is just as true for soil surveys and the application of aerial photography to forestry.

Although the Food and Agriculture Organization of the United Nations proposed to add this item to the agenda of the Cartographic Conference, we do not believe that it will be possible to enter into the details of this subject. It is well known that surveys of this kind—by means of photo-interpretation—have to be carried out by specialists using their particular techniques. A soil survey by photo-interpretation can only be carried out and studied by a soil scientist.

There is, however, a close relation between the various aspects of interpretation. In some cases geology and soil survey have to go together. We have seen in productive surveys, carried out in the Delft International Training Centre, a close co-operation between the various sections for photo-interpretation. In particular, the soil surveyor profits greatly by the information obtained by his two colleagues. Therefore we have combined in the Delft International Training Centre these three different sections of economic interpretation of air photographs for the study of natural resources.

That, furthermore, the combination with a little photogrammetry is very useful is obvious, because the results of these interpretations must always be represented on maps. In certain circumstances use of air photographs for economic purposes is ahead of construction of maps. In that case the section for photo-interpretation has to help itself by compilation of approximate maps by means of very simple methods. Nevertheless, some knowledge of photogrammetry is necessary in order to be able to apply the most economic method for this kind of compilation work. In recent years many areas have been photographed, not primarily for map-making, but for the economic interpretation. In this respect there might be mentioned the enormous areas which have been photographed in the search for oil. No oil company starts new exploration without first having taken air photographs.

The same photographs, however, which have been taken for geological purposes can in many cases also be used for other interpretations, though the scale of photography possible for good geological interpretation may be much smaller than that required for a semi-detailed soil survey.

What holds good for geological exploration will also shortly become true for soil surveys. Until recently use of air photographs in soil surveys was generally closely related to use of the photographs as a map. Sometimes a photomosaic, sometimes separate prints were used as maps on which the results of soil survey in the field were indicated.

The International Training Centre-Buringh method presented at the 1954 International Congress of Soil Science in Leopoldville may be mentioned. It is, from the point of view of soil scientists, a real photo-interpretation in combination with an adequate quantity of field work. This method has the great advantage that it is not a kind of black magic but can be taught to everybody. It proved that economy in field work of about 50 to 75 per cent was possible for so-called semi-detailed soil maps on a scale of about 1:50,000 if air photographs of moderate quality on a scale between 20,000 and 30,000 are available. Even with photographs on the scale 1:40,000, provided that they are of excellent quality, very reliable results can be obtained.

The new methods of photo-interpretation in soil surveys and land classification are of the utmost importance for large countries with a thin population. In these countries the necessary normal soil survey is so expensive that in some cases the work is not

started, while in others only very extensive surveys are carried out.

From the point of view of agriculture, in particular land classification, and of efforts to increase agricultural crops by means of irrigation and other methods, this rapid and cheap method of soil survey must be considered as a recent development of the utmost importance for the study of natural resources.

#### GENERAL REMARKS ABOUT SUB-ITEMS 7 (ii), 8 (ii) AND 8 (iii)

There is a close relation between the subjects mentioned in these three agenda sub-items. Sub-item 7 (ii) deals with inter-governmental cartographic studies and providing the less developed countries with aid resulting from these studies. In sub-item 8 (ii) the Government of Burma considers the possibility of studies to be made by officials from less developed countries in more developed countries. This would then not be aid from outside but helping themselves by means of studies carried out outside the country. In sub-item 8 (iii) the popular term "technical assistance activities" is used, which can cover sub-items 7 (ii) and 8 (ii) as well as 8 (iii). It is obvious that in both sub-items 7 (ii) and 8 (ii) the basic principle has been accepted that no technical assistance has any sense if its aim is not to make itself superfluous as soon as possible. This means that the national organizations should as quickly as possible be provided with the necessary knowledge and means to carry out their mapping programme independently, without foreign aid, except in a few cases, as under sub-item 6 (b) (i), where economic reasons can make use of foreign organizations desirable. This, however, is nothing extraordinary and can be compared with the normal import trade in goods which are produced better and more economically elsewhere.

#### ESTABLISHMENT OF AN INTER-GOVERNMENTAL CARTOGRAPHIC ORGANIZATION

The Committee of Experts on Cartography which reported to the Secretary-General of the United Nations in 1949 discussed the possibility of creating a cartographic section such as may be envisaged in sub-item 7 (ii), to be part of the United Nations Secretariat and to work out uniform international cartographic standards. The Committee came to the following conclusion:

"Work on the standardization of symbols and of procedures has been the continued preoccupation of many international organizations. This is a type of research and contribution to the advancement of science which such organizations are eminently qualified to perform. We do not feel, therefore, that it is necessary for the United Nations to enter this field directly. It would be fitting, however, to encourage the interested bodies to continue their important work."<sup>1</sup>

<sup>1</sup> *Modern Cartography: Base Maps for World Needs* (sales number: 1949.I.19), page 42.

The proposal of the Burmese Government, however, proves that at least in the opinion of this Government the Committee of Experts has been too optimistic. It is true that several organizations are still working on this subject. The international scientific unions can study the scientific problems connected with the establishment of such international cartographic standards. Their authority, however, is insufficient to have these standards accepted by governments. There are only a few examples of organizations working in this direction. One is the Pan American Institute of Geography and History. It is believed, however, that the task discussed in 1949 has still to be accomplished. The undersigned<sup>2</sup> is in favour of regional organizations such as the Pan American Institute of Geography and History. Therefore, we consider it desirable to give the present regional conference a permanent character in order to render the same kind of services to the Asiatic countries on an inter-governmental level.

The second point mentioned in sub-item 7 (ii) deals with the aid to be given to less developed countries in order to expedite the survey of the world. This, however, is a very difficult subject. If it is considered from the point of view of item 8, a general view can be obtained of the financial aid given by some governments to governments of Asiatic countries. An important example is the Canadian assistance to Pakistan within the scope of the Colombo Plan. There are other examples of cartographic programmes within the scope of military assistance, either being carried out or under discussion. I do not know, however, whether the Government of Burma had these examples in mind when proposing item 7 (ii) of the agenda, which mentions the required aid to less developed countries, comparing it with aid furnished by other inter-governmental organizations. It is doubtful whether the very useful step taken in some instances to expedite the survey of the world can be considered as carried out by "inter-governmental organizations". So far the only really inter-governmental organization is in the United Nations; it is to be regretted that the financial means made available by various countries for foreign aid are on a bilateral basis, instead of contributions to the Technical Assistance Administration of the United Nations. In addition to the political advantages of the latter, the technical advantage would be that not only the means of one special country but of all countries would become available. It is doubtful, however, whether the proposal of the Government of Burma is directed towards considerations like these.

#### CENTRAL RESEARCH ORGANIZATION

Establishment of a central research organization or office is suggested. Similar proposals had previously been made in Europe. There the necessary funds would be furnished by the governments willing to join this organization. From discussion it became clear that this plan could only be realized for a few spectacular subjects, such as atomic energy. The result of these discussions has been that it seems

<sup>2</sup> Dr. W. Schermerhorn, representative of the Netherlands

preferable to use the existing facilities in the various countries and to create not an institute, but only an organization.

Therefore on 12 October 1953, the representatives of the Governments of Austria, Belgium, Germany and the Netherlands, on behalf of their Governments, signed a convention by which the European Organization for Experimental Photogrammetric Research (EOPER) was created. Later on, Switzerland joined the organization, which has at present six members; discussions are still going on with a few other countries regard to joining it.

Although the organization has no central institute, it has its own headquarters in the International Training Centre for Aerial Survey at Delft (ITC). The Steering Committee took this decision because the Delft ITC intends to act as much as possible like a really international and wholly independent and neutral institute. This is an aim which can easily be attained because the Netherlands has no national photogrammetric industry.

It may be useful to give the Conference a few other facts about the Delft training centre established in 1951. The Netherlands Government accepted the proposal for such a centre, and the Delft Institute of Technology and the Wageningen Institute of Agriculture established it. The centre has the following functions:

(1) To operate as a scientific centre, carrying out its own research programme and making it possible to compare the techniques used in different countries.

(2) To disseminate knowledge and experience as widely as possible by (a) giving training in all branches of aerial survey; (b) affording the possibility of consulting experts from among the staff.

(3) To carry out on a non-profit basis scientific research in photogrammetry and all kinds of photo-interpretation.

It is obvious that what the Government of Burma proposes is exactly the task of the ITC mentioned in paragraph (3). In order to fulfil this task the ITC has been provided with a complete collection of photogrammetric equipment, which will be kept up to date by purchase of all valuable new instruments. Furthermore, its photogrammetric section has a large staff, including experienced operators, so that it is in a position to take a large part of the heavy burden of the European Organization for Experimental Photogrammetric Research. It is obvious that the character and set-up of the Delft ITC constituted one of the most important reasons for the European Organization for Experimental Photogrammetric Research to establish its headquarters in Delft.

At present the organization carries out important experimental work. The results of all observations are studied by different scientific committees on the various subjects. All results will be compared and elaborated at its headquarters. After they have been accepted by the scientific committees concerned, they will be published and made available to the whole photogrammetric world. It is obvious that in this way the countries co-operating in this European organization

are rendering important services to photogrammetry as such and to all other countries desirous of applying this method to their mapping programme.

Moreover, certain controlled experiments are organized within the scope of the International Society of Photogrammetry following a proposal by the French Institut géographique national. This programme deals mainly with the problems of aerial triangulation and the co-operation so far is limited to France's Institut géographique national, the Delft ITC and, in part, Switzerland.

In conclusion, we believe that the Delft ITC, in addition to its educational function, can render important services as a central research office to which problems can be referred and from which up-to-date information about various instruments can be obtained as is required by the Burmese Government. Therefore, we believe that for the Asiatic countries the Delft International Training Centre for Aerial Survey can fulfil the task outlined by the Government of Burma in the same way as it does at present for the EOPER.

It is an open question whether the Asiatic countries will create an organization parallel to the European organization or whether they will establish a contact between each country and this European organization on a special basis. The Executive Committee of EOPER is willing to discuss this problem at the next meeting of its Steering Committee.

#### *Facilities for the Less Developed Countries to Study new Developments in Neighbouring Developed Countries*

Regarding this subject reference may be made to the above discussion of sub-items 7 (ii) and 7 (iii). Facilities for the less developed countries to study new developments in neighbouring developed countries can be provided in a different way. First of all, it will be necessary to educate as many national technicians as possible. For staff members this should be done to such an extent that they take full advantage of the study of new developments in other countries. Furthermore, there are different kinds of fellowships, not only for elementary studies but also for advanced studies. Based on experience during the past several years, the following recommendations can be made:

(1) Persons who wish to obtain a fellowship for advanced studies must have sufficient preliminary education and preferably already some experience in the field of cartography. Furthermore, it should be practically sure that after their return they will take up again a position in this branch.

(2) It is of only limited value to send Fellows without the necessary preliminary education through many countries and services if they spend only a short time in each. Even a well-trained specialist who knows the details of cartography perfectly receives limited value from such trips, if no special precautions are taken.

(3) There is a certain danger in sending Fellows to one particular country only, because so far—for instance in the field of photogrammetry—certain countries have developed their own special national

industries and methods. This makes objective comparison and evaluation very difficult. It is one of the fundamental principles in the Delft ITC that all methods and instruments are the subject of study without any special preference. After such study on a general and unprejudiced basis it can be useful to send Fellows for a longer period to a particular country in order to study special methods. It is also useful after thorough preparation to send a group of Fellows, under the guidance of a responsible institute, to several different

services, institutes and factories in Europe or elsewhere.

(4) It would be useful to give advanced photogrammetrists, for instance, the chance to co-operate in the experimental work of the European Organization for Experimental Photogrammetric Research. This can be done either in one of the institutes of a member country or in the headquarters of this organization in the Delft ITC. The Delft institute has the advantage that there all new developments which are published elsewhere are tested and checked by its staff.



# PHYSICAL BACKGROUND SURVEYS FOR A STUDY OF NATURAL RESOURCES FOR AGRICULTURE

by

F. George

*Food and Agriculture Organization*

(The original text of this paper appeared as document E/CONF.18/A/L.8)

As was recognized in the 1949 report to the Economic and Social Council<sup>1</sup> on the co-ordination of cartographic sciences, the Food and Agriculture Organization has been primarily a user of maps rather than a contributor to world cartography in such fields of operation as soil surveys and forest inventories, where it has long been concerned in promoting a specialized cartographic activity.

As a user of maps, however, the Organization has special needs, and the purpose of this paper is to examine those needs which arise in the study of natural resources—a study which clearly falls within the responsibility of promoting higher standards of living by broadening and developing the basis of production. Such a study must include the assessment both of resources as they are now utilized and of resources as yet relatively unexploited. It is for the development of unused resources that adequate cartographic material is at once most needed and most difficult to obtain. This aspect will therefore provide the major subject for the present discussion.

It is not necessary here to set out at length the variety of maps relevant to resource development, or the successive phases of planning and execution in which they will be employed. This has already been done in a paper by Randall and Sweet in *World Cartography*,<sup>2</sup> and frequent reference will be made to the cartographic programme outlined in that paper: preliminary examination, general coverage, specific coverage, intensive survey, construction surveys, operational surveys. Attention will be directed rather to the nature of the physical factors which must be studied and to the way they influence the decisions as to choice of scale and content in cartographical treatment.

In agriculture and forestry the basic physical factors are climate, water supply, soils and topography; for fisheries, oceanographical factors are of course decisive and their cartographic treatment is a subject in itself.

## CLIMATIC FACTORS

Because climate is a fundamental determinant of the natural flora and fauna of any site and indeed of the characteristics and properties of the soil in which plants grow, and because it is, of all physical factors, the least amenable to human modification, we may well consider first the cartography of climatological factors.

The principal meteorological elements involved are insolation, temperature, precipitation, evaporation and humidity—and their variations. A major difficulty in mapping them in little developed areas is at once apparent, for reliable mean values can only be obtained from long series of observations. There is, however, an equally important relaxation of the cartographic requirement: the meteorological elements themselves are not usually susceptible to significantly rapid variation from point to point. Except for micro-climatological studies, with which we are not here concerned, climatic maps can be on small scales, and differentiation of significant climatic régimes is to be aimed at rather than any exact delineation of the meteorological factors proper to any given point on the ground. Again, the degree of possible refinement will not greatly increase with the successive phases of the development project except in so far as the accumulation of observations provides more reliable mean values. Since, however, a thirty-year series is generally regarded as the shortest which can be accepted with any approach to finality, this is not likely to be reached before an individual project has been implemented. It is, therefore, all the more necessary that meteorological networks should be set up wherever they are still lacking, and without reference to a specific or immediate project for resource development.

The delineation of climatic régimes for the study of resource development presents interesting and important cartographical problems. Crude figures for precipitation, temperature or humidity, however reliable, give but a poor indication of the biological resultant; therefore what is also required is some such climatic index as that furnished by Köppen's classification of climates<sup>3</sup> or by Thornthwaite's concept of evapo-

<sup>1</sup> United Nations, *Modern Cartography: Base Maps for World Needs* (sales number: 1949.I.19), part I.

<sup>2</sup> United Nations, *World Cartography*, vol. I, part I: "Cartography as related to Resource Development", by R. H. Randall and A. J. Sweet (sales number: 1951.I.9).

<sup>3</sup> B. Haurwitz and J. M. Austin, *Climatology* (New York, 1944).



transpiration.<sup>4</sup> It must be noted, however, that for any specific project there will often be some single factor, such as the incidence of early or late frost, of special significance to agriculture, although not in itself a criterion for climatic classification. It is worth while examining a little the implications of any such climatic index, although a digression into meteorological theory would be out of place. Koppen's method is frankly empirical. It has the merit of requiring only a knowledge of the annual distribution of temperature and precipitation for a certain number of stations, and the arbitrary numerical limits which it employs are intended to fit best, in general, with the observed limits of certain vegetation types. Thornthwaite's classification, in adopting as its basis the water exchanges status of the atmosphere through the year, aims at something less empirical; but it requires either direct observations of evaporation, which are seldom available, or an assumption that correlations established over limited areas can be applied generally. It might well be argued that this assumption reduces the method to the same empirical status as the Koppen system.

To return to the cartographic presentation of climatic differences, it is worth noting that a recent version of the Koppen classification recognizes only some six climatic types within Burma, Ceylon, India and Pakistan. For a study of resource development, is so broad a classification useful or realistic? As a background to the closer pattern of isohyets and isotherms which can generally be drawn from available records, one feels that it is. The suggestion may be made that these climatic types should be overprinted in colour tints on, for example, rainfall and temperature maps. They would show the varying significance of the recorded rainfall and temperature and, at the same time, the variations in rainfall and temperature would emphasize the progressive change within any one climate type. A comparison of such composite maps from different parts of the world might shed a good deal of light on development possibilities and assist greatly in a world survey of latent resources. Again, limiting factors may be of special significance in agriculture. In the rice lands of India and Burma, falling as they do within the relatively uniform régime of the monsoon, one might recognize a mean annual rainfall more or less than about forty or fifty inches as specially significant; for, however much more the rainfall may be, rice cultivation will probably be the dominant type of agriculture.

A further refinement to climatic classifications for local use suggests itself. As has been noted, the numerical limits on which both the Koppen and Thornthwaite classifications are based were adjusted to fit the general distribution of natural vegetation. A local comparison would probably lead to a better choice of limits for local use and to the identification of climatic sub-classes, possibly of considerable local significance. Mention should here be made of Boyko's work in Israel on the delineation of rainfall distribution in desert lands from the natural flora, in the absence

of rainfall records,<sup>5</sup> and of similar work by Tothill on the species of *Acacia* as indicators of rainfall distribution in Saudi Arabia.<sup>6</sup>

In the absence of long series of meteorological observations, one must look to the skilful integration of all available evidence in studying the climatic factors which determine potentialities for agricultural development or the introduction of exotic forest species.

## WATER RESOURCES

All useful water derives, directly or indirectly, from precipitation. It is where the direct supply is inadequate or excessive that the exploitation or control of water resources becomes an important factor in agricultural development. Any estimate of this defect or excess requires some knowledge of the climatic data just discussed, while exploitation or control calls for a more detailed local knowledge of the precipitation, run-off and infiltration.

Little more can be done to record the precipitation than what has been outlined above, but the importance of an adequate cartographic treatment of the data is particularly evident where the incidence of precipitation within a catchment varies rapidly with altitude and aspect. As an example, the relatively short wadis of the Asir Tihama of Saudi Arabia extend from an escarpment at an altitude of some 7,000 feet, enjoying the sub-humid climate of Yemen, to the arid coastal plain of the Red Sea, while the region as a whole is marginal to the régimes of the monsoon and the Mediterranean winter rainfall.<sup>7</sup> Equally complex patterns will be found in Baluchistan and the North-West Frontier Province of Pakistan, and in the zone of transition from monsoon rainfall to perennial snow along the southern slopes of the Himalaya.

These climatic considerations will govern the phases of preliminary examination and general cartographic coverage defined by Randall and Sweet in the article mentioned above for any project dealing with surface water development. The phases of more specific coverage and of intensive survey will call for a close network of stream-gauging stations and measurements of run-off and evaporation in the project area. These are subjects for the engineer and the hydrologist rather than the cartographer, but a minimum requirement for such studies is an adequate topographical map. The silt load of the streams, itself a reflection of the topography, geology, soil and vegetative cover of the watershed, is equally important. It will determine the useful life of a reservoir, as the run-off will determine the irrigable area and the magnitude of the retaining dams that must be built. The economic justification for the project must rest on a balance of the costs of construction and maintenance against the extent and duration of the benefit derived. Extensive erosion control to protect the watershed may become an

<sup>4</sup> C. W. Thornthwaite, "The Climates of the Earth", *Geographical Review* (New York, 1943), pages 232 to 255.

<sup>5</sup> *Palestine Journal of Botany* (1947).

<sup>6</sup> J. D. Tothill, *Report to the Government of Saudi Arabia on Agricultural Development*, FAO Technical Assistance Report No. 76 (Rome, 1953).

<sup>7</sup> *Idem*.

ential condition for success and this will call for the specialized cartographic material.

Although ground water supplies are atmospheric origin, their relation to climatic factors is generally indirect as not to influence projects for development. The essential cartographic material relates to the water-bearing strata and the water-table. In the stages of preliminary examination and general coverage, a geological reconnaissance survey will either indicate areas for exploratory drilling or enable more general conclusions to be drawn from the characteristics of the wells as they may already exist in the area. In the later stages of specific coverage and intensive survey, the location and altitudes of all well sites, the thicknesses of strata penetrated and the records of well tests and water yields call for precise cartographic treatment. These factors must be built up into a composite three-dimensional picture of the ground water reservoir. The best development of the resources is to be achieved, and exhaustion of the water by overpumping avoided. The geological complexity of the area may call for specially detailed mapping and add to the cartographic problems of the project engineer.

The ground water supplies of the great deserts should present a special field of interest to the map-maker, for the water must come from distant areas of replenishment. To trace its course, estimate the depth at which it will be found and forecast its quality and abundance, calls for a synthesis, and therefore a map, based on whatever evidence may be available. One may refer to the long series of studies on the water resources of the Nubian sandstone below the western deserts of Egypt, ably summarized by G. W. Murray.<sup>8</sup>

In all ground water development, modern advances in geophysical exploration add greatly to the prospect of success; to use them requires precise measurements and the ground and accurate maps for the practical interpretation of the observations.

The disposal of ground water may become as important as its exploitation where irrigation is practised in arid and semi-arid climates, if sustained yields from agriculture are not to be jeopardized by a rising water-table and increasing soil salinity. Similar cartographic material is needed for the study of the subsurface structure and water régime and may point the way to appropriate agricultural practices and drainage systems. The rising water levels of the Punjab are vividly portrayed in a series of contour maps of the water-table which have been prepared from well observations extending over a period of forty years or more; the local features of these contours have still to be satisfactorily correlated with the causes of waterlogging.<sup>9</sup>

The over-all need for topographical maps in any project for water development hardly needs to be stressed. Any irrigation or drainage layout calls for

large-scale maps with close contours while the selection of sites and the engineering design for dams and reservoirs requires the most detailed topographical and geological surveys.

#### SOIL SURVEYS AND VEGETATION MAPS

Soil maps constitute so distinctively agricultural a contribution to the world's cartography that their relevance to the study of natural resources is evident; their importance for land development is fully reviewed in a study recently published by the Food and Agriculture Organization.<sup>10</sup> It is, however, worth while to consider the various phases of soil survey which should be associated with the phases of project development.

For the preliminary examination and general coverage of any extensive area, the first requirement in this field is a map of the principal soil groupings. The distribution of these broader categories is so closely related to the pattern of land forms and to the natural vegetation types which they favour, that a most effective aid in any reconnaissance soil survey is a set of air photographs suitable for stereoscopic examination. But what is required is not the picture itself; the map must embody an effective classification and interpretation of the relevant soil factors, including factors which operate below the surface. The land forms must be seen in the light of the parent material from which they are derived and the physical processes of denudation, accumulation or weathering which have accompanied their evolution. Even if the field work is plotted on the photographs rather than on a topographical sheet, such a survey is cartographic in its method.

The phase of specific coverage in an area chosen for development will involve preparation of more detailed maps with a view to determining the proper use of the land, its suitability for irrigation, or the necessity for drainage or flood protection. But in this phase, as in all others, we are concerned more with the physical factors, the inherent character of the soil, than with a mere classification of possible uses. The best use of the environment is, or should be, deducible from a full understanding of its character. The direct use of air photographs will still be of immense value, but the survey will require a close network of soil sampling and subsequent laboratory analysis. The data must be put on the map. Experience has shown over and over again that to embark on irrigation projects without adequate soil surveys is to risk the diversion of a precious water supply away from the land where it could have been used to better advantage, and to invite future problems of increasing soil salinity.

In the operational phase of land development, detailed soil surveys form the basis for co-ordinating fertilizer experiments and formulating advice for the application of soil amendments on particular farms and fields.

<sup>8</sup> G. W. Murray, "The Water beneath the Egyptian Western Desert", *Geographical Journal* (London, 1952), pages 443 to 452.

<sup>9</sup> C. W. Carlston, *History and Causes of Rising Ground Water Levels in the Rechna Doab*, FAO Technical Assistance Report No. 90 (Rome, 1953).

<sup>10</sup> C. G. Stephens (Editor), *Soil Surveys for Land Development*, FAO Agricultural Study No. 20 (Rome, 1953).

The pattern of natural vegetation is yet another indication of the physical factors of the environment: climate, water supply and soil. It may be an index to the deterioration of the environment under improper use. But the natural vegetation may also be a resource in itself for the development of forestry and animal husbandry. There will be the same sequence of reconnaissance, detailed survey and operational survey, to select areas for appropriate uses and to estimate the immediate or sustained yield in forest produce, or the carrying capacity in terms of stock. Empirically conducted, the survey may be an inventory of capabilities, but for a fuller understanding, and to prevent improper use and deterioration, the floristic composition and ecological status of the vegetation are equally important.

#### FISHERY RESOURCES

The cartographic requirements for water areas are rather different from, and in some ways more complex than, those for agriculture and forestry. In the first place, the area involved is much greater, about 72 per cent of the earth's surface being covered with water. It is only recently that developments in echo sounding have provided means to overcome the practical difficulties of obtaining sufficient data even for the relatively simple task of charting the physiographic features of the water basins. These charts can provide the basis for mapping water masses and currents, the distribution and variation of the physical properties and chemical composition of the water, and of various biotic elements and communities. The cartographic problems are complicated by the essentially three-dimensional character and by the dynamic properties of the systems which constitute the aquatic resources. As for the dynamic aspect, it is not merely that the medium of these systems is fluid and in motion—in which respect they could perhaps best be compared with atmospheric systems—but that the water systems are the growing media of the resource. In measuring their properties—especially their productive potential—and in mapping these measurements, it is also necessary to consider the history of the stocks and of their nutrient reserves.

It is necessary both in the case of inland waters and in marine waters to deal separately with the water basins, the water—its physical properties and chemical composition—and the biota. In all three categories, improvements in scope, coverage and detail are urgently needed, but for the water and also for the biota—which too, may move both horizontally and vertically, and vary rather rapidly with time—cartography has a special contribution to make in techniques for representing such complex systems in a way which will assist our understanding of them.

#### TOPOGRAPHICAL MAPS AND AIR PHOTOGRAPHY

Many incidental references have already been made to the need for adequate topographical maps. What class of map may be regarded as adequate will depend on the stage of project development and on the rapidity with which the natural factor under consideration

varies from point to point on the ground. It has been noted in the discussion of climatic factors that small-scale maps are usually sufficient. At the other extreme, the cartography for an irrigation layout or for the soil survey from which fertilizer applications are to be prescribed must often be on a scale of 1:5,000 or larger.

It has been noted that air photographs may be an almost indispensable aid to the study of physical factors for resource development. Yet photographs are no substitute for a cartographical treatment of such problems. The surface pattern that is visible in a photograph, being the resultant of many factors—physical, biological and human—is not in itself a record of the incidence of any one of them. The task of making a map, whether it be a contour map or a soil map, begins after the photographs have been taken. It is a cartographical achievement whether much or little of the survey is done in the field and even if a photomosaic is used as a base for the final drawing.

There is also the problem of generalization, always present to the cartographer, and this does not relate merely to the interpretation of air photographs. The mechanical processes of drawing and reproduction do not alone determine what can, and what cannot, be shown on a map of a given scale, as may be seen from the conventional representation of roads and railways. In the mapping of physical conditions, associations of related factors can be generalized even when the environment is uniform only over extremely small areas. Thus, the recognition of typical associations, whether of plants or types of soil, or for example, of alluvial valleys among less fertile uplands, may make possible the reconnaissance mapping of environmental factors on scales far smaller than would be needed to show their individual occurrences. It is necessary that the pattern and components of such an association should be carefully studied and defined before it is adopted as a unit for generalization.

Although the cost of resource surveys may be only a small fraction of the total investment in development, the time needed for their completion may greatly delay the inception of a project, or, worse still, lead to the temptation of taking vital decisions before the physical background has been sufficiently studied. This is particularly true of the preliminary examination and general coverage, which will probably include an area far wider than that which will ultimately be chosen for the site of the project. The more detailed surveys of the selected area are less likely to be neglected and will probably be concurrent with other operations. The delay and expense attending these critical preliminary studies will be greatly reduced where the country is already well mapped on medium scales and where a good photographic coverage is already available.

This is where the national agencies charged with the survey of a country can best anticipate its cartographic needs for resource development. There will no doubt be a survey programme for covering the territory on a uniform scale and for providing the necessary primary and secondary triangulation. If this programme is systematically pursued, much of what is needed for general coverage and preliminary exa-

nation will be at hand when development projects are planned.

But there should also be an intelligent anticipation of special needs in specially promising areas. If the aerial coverage is on the scale of 1:100,000 or 1:200,000, scale of at least 1:50,000 and a correspondingly closer contour interval, as well as a closer network of tertiary angulation and levelling, would be justified in areas of potential development. The air photography from which the topographical sheets will probably, nowadays, be derived may with great advantage be similarly selective in its scale and quality. The preparation of special topographical maps on large scales can then be taken up as the necessity arises, and with less delay than subsequent field operations.

What has been said of national topographical surveys applies equally to national surveys of all other types, for example, the geological and the soil survey. Most of all, because observations conducted regularly over many years are necessary for reliable estimates, a meteorological and hydrological network for the whole territory should be regarded as a national necessity.

#### OPERATIONAL SURVEYS IN AGRICULTURE

This paper has dealt almost exclusively with surveys of the physical background for resource development. The present use of natural resources is equally worthy of study. It is the clue to their possible future development for more complete use and to the latent potentialities of similar environments hitherto unexploited. It is also fundamental to any sound judgment on the dilemma of the present age—whether the total resources of the world can provide for the growing needs of an increasing population. Every source of raw materials must contribute to the needs of the future and where, often, there are competing uses for the same resource, the study of them is all the more important. It may well be that the greatest increases in world resources will come not from the opening up of new lands, but from more extensive use of areas already exploited. Relatively, these are no doubt the better mapped areas, for the physical and economic factors which determine their productivity call for even more penetrating analysis and presentation.

The cartographical treatment of operational surveys in agriculture and forestry presents many interesting topics which there is no space to consider here. The problem may be to put on a map the relevant statistical material which is already available in public or private records, or to survey the physical factors which influence the productivity of an established agricultural system—

the incidence of frost, sunshine, or drought, or the spread of a disease.

Something must be said of the mapping of agricultural and forestry enterprises as such, either on land use maps or, for the identification of the individual enterprise and its economic status, on the cadastral plan. Although this is less directly related to the physical background, it is fundamental to a full understanding of the utilization of natural resources. The world over, agriculture is predominantly an industry of small producers; the cadastre is the key to the units of production. It is also the key to any rational adjustment of these units in the changing technical and economic environments of the present age. The administration of land, its taxation and valuation in the general interest of the community, and the organization of agricultural credit, all call for an efficient land register and a cadastral map.

#### CONCLUSION

We have reviewed in this paper the relation between the cartographical treatment of the physical factors which determine resource development and the successive phases of a project. At every stage it is the way in which the incidence of a factor influences the decisions that must be taken that should determine the scale and content of the map. This is perhaps clearest in the contrast between climatic and topographical factors; the former are general, the latter special and local.

We have seen also that the earliest phases of development call for critical decisions, based on the general examination of a relatively wide area, before the location and scope of the project are determined. It is here that foresight in the policies of national survey departments can perhaps contribute most to progress.

India furnishes an example of departmental surveys, carried on over many years according to well considered programmes, which have built up a volume of cartographic material that few, if any, States of the same size can possess.<sup>11</sup> The geodetic triangulation was virtually complete before 1900, and a topographical map series, generally on the scale of one inch to the mile, now covers all but a small part of the country; nor were geophysical and meteorological data neglected. In keeping with the needs of the times, since 1945 there has been a concentration on special surveys for anticipated resource development, including topographical surveys on larger scales (1:25,000 to 1:15,000) and precise levelling for irrigation.

<sup>11</sup> G. F. Heaney, "The Survey of India since the Second World War", *Geographical Journal* (London, 1952), pages 280 to 296.

## COMMUNICATION RECEIVED FROM THE INTERNATIONAL CIVIL AVIATION ORGANIZATION

(The original text, taken from a letter dated 18 June 1954, appeared as document E/CONF.18/A/L.9)

### COMMENTS ON SEVERAL ITEMS OF THE AGENDA

#### *Item 5*

A summary of progress made in the production of aeronautical charts of the International Civil Aviation Organization (ICAO) could be made available to the meeting. It may, however, be considered preferable for States to report individually.

#### *Sub-item 6 (b) (iv)*

The specifications governing the writing of geographical names on maps contained in annex 4 to the Convention on International Civil Aviation have not been further developed. They appear to meet adequately the needs of ICAO.

#### *Sub-item 6 (g) (i)*

If it is intended to revise the specifications governing the International Map of the World (IMW) series, it is suggested that relevant specifications of the ICAO World Aeronautical Chart (WAC) 1:1,000,000 should be adopted whenever this is possible without detracting from the value of the IMW series. In view of the development in recent years of specialized aeronautical charts, it may well be desirable to omit from the IMW series information intended to facilitate air navigation.

#### *Sub-item 6 (g) (ii)*

For the sparsely populated areas of the world the production of both the IMW series and the ICAO WAC series might not always be justified. In such cases

it should be recognized that, although the WAC might serve the purpose of the IMW, the latter could not be used for the purpose of air navigation. It is suggested that when the geographical area to be covered by the IMW series permits the use of the WAC sheet lines, these should be adopted in the interests of uniformity.

#### *Sub-item 6 (g) (iii)*

In considering the allocation of responsibility for production of the IMW series, it is suggested that the areas of responsibility should be aligned as closely as possible with those agreed on by States for the ICAO WAC 1:1,000,000, modified if necessary, since this would ensure maximum economy and reduce to a minimum the exchange of topographic information between States.

#### *Sub-item 7 (ii)*

An organization could with advantage be established to provide machinery for co-operation among governments in the cartographic field, to co-ordinate the related activities of the various international organizations and to provide effective administration of regional consultations on cartography.

The necessity for such an organization to be established as a type of specialized agency is a matter which needs further study and which might well be undertaken initially by a regional group such as the proposed conference. If in due course the establishment of such an organization is recommended, ICAO would be vitally interested in its character and functions and would be pleased to make known its views fully at the appropriate time.

## COMMUNICATION RECEIVED FROM THE UNIVERSAL POSTAL UNION

(The original text, taken from a letter dated 13 October 1954, appeared as document E/CONF.18/A/L.10)

The International Bureau of the Universal Postal Union is entrusted, by virtue of article 108, 4, *e* of the regulations of the Brussels Universal Postal Convention present in force, with the publication of a World Map of Surface (by land or sea) Postal Communications (*Carte des communications postales internationales de surface*) and also with an annex giving the exchange offices and the countries for which they serve as intermediaries. This map and this annex are prepared on the basis of data furnished by the postal administrations of the various countries.

On the map the names of countries are given in French, which is the only official language of the Universal Postal Union (UPU). Place names are produced in the manner indicated in the *World Directory of Post Offices*, which is published by UPU on the basis of official information furnished

by the postal administrations in the various countries.

This procedure has not hitherto entailed any difficulty for the postal administrations and it is proposed to apply it again for the new edition scheduled for next year.

In the event that the Regional Cartographic Conference for Asia and the Far East should adopt a method of writing geographical names on maps which is incompatible with the practice used by UPU for the publication of the *Carte des communications postales internationales de surface*, I would ask you kindly to advise me accordingly, so that I may, after having obtained the views of the postal administrations, examine the changes that we might, if necessary, introduce in future for the writing of geographical names on the map in question.

## COMMUNICATION RECEIVED FROM THE DELEGATION OF INDIA

(The original text of this paper appeared as document E/CONF.18/A/L.11)

### OBSERVATIONS ON SEVERAL ITEMS OF THE AGENDA

#### *Sub-item 6 (a) (i)*

At present, the geodetic framework on which the mapping of the outlying islands, like the Andamans, Nicobars and Laccadives, has been based is unconnected with the main triangulation framework of India. A connexion cannot be effected by ordinary means, and it is therefore essential to have recourse to electronic methods, such as Shoran and Loran, to achieve this and also to fulfil the long-cherished objective of linking the Indian triangulation to that of Australia, via Indonesia, by filling up the intervening gaps. It is therefore desirable to take steps towards the study and application of such methods to the above cases as early as possible.

#### *Sub-item 6 (a) (ii)*

At present geodetic base measurements in India are carried out by means of invar wires or tapes standardized by comparison with Indian standard bars (of nickel, silica and the like, one metre in length), which in turn are periodically compared at the National Physical Laboratory against British standards. These physical standards are now fast becoming obsolete and are being gradually replaced by natural standards, such as light and electric waves. In accordance with a resolution adopted at the General Assembly of the International Union of Geodesy and Geophysics held in Brussels in 1951, it is now desirable to measure with the Väisälä comparator one or more base lines in India and neighbouring countries which will serve as standards for comparing base-line measurements.

#### *Sub-item 6 (a) (iii)*

Magnetic surveys and gravity observations in India and adjacent countries have so far been confined to the land areas. Without any observations in the Bay of Bengal and the Arabian Sea, it is not possible to obtain a complete picture of either the magnetic or the gravity field in the whole region. The magnetic observations in these seas are essential for bringing the isogonal charts up to date. In the isogonal charts prepared for epoch 1953.0, the values in these sea areas have had to be extrapolated since data were lacking.<sup>1</sup> Similarly, as regards gravity, the existence of a "hidden range" of excessive density in the Gangetic plains in

India and of a similar range running from Burma to Sumatra has been revealed by observations already made, and it would be of the utmost interest to demarcate the full extent and nature of these ranges by gravity observations in the neighbouring Bay of Bengal and Arabian Sea. These observations would also supplement the existing data in the study of the world geoid.

#### *Sub-item 6 (a) (iv)*

At present, magnetic operations in India are carried out mainly by the Survey of India and the Meteorological Department. Various instruments are in use for measuring both the absolute and differential values of the magnetic elements, but there are no standards in India with which to compare and calibrate these different instruments. It is therefore desirable to maintain one set of such instruments as the national standard and arrange for its periodical comparison with the European standard.

#### *Sub-item 6 (b) (iii)*

In certain countries, notably India, cadastral surveys are so divorced from national trigonometrical or topographical surveys that their usefulness is limited to the purely local purpose of revenue administration and property demarcation. These cadastral surveys are usually executed in isolated patches, based on local systems of framework control with different standards of accuracy and different origins, and bear no relationship to national trigonometrical data. Contiguous surveys, being based on different terms with different degrees of accuracy, often do not fit; their accuracy is frequently as low as 1/200; and the maps show no topographical detail or contours. In consequence of all these factors, the resulting cadastral maps cannot be used either for the compilation of small-scale topographical maps by reduction from them or as a suitable basis for the execution of large-scale project surveys in the respective areas. For these latter, the same area which has once been surveyed for cadastral mapping would have to be surveyed again, a procedure which leads to unnecessary expenditure and some waste of time.

Again, in India and perhaps also in some other countries, the Cassini projection is used for cadastral maps. In India the polyconic projection (gradually being replaced by the Lambert) and the conical orthomorphic projection are used for topographical maps.

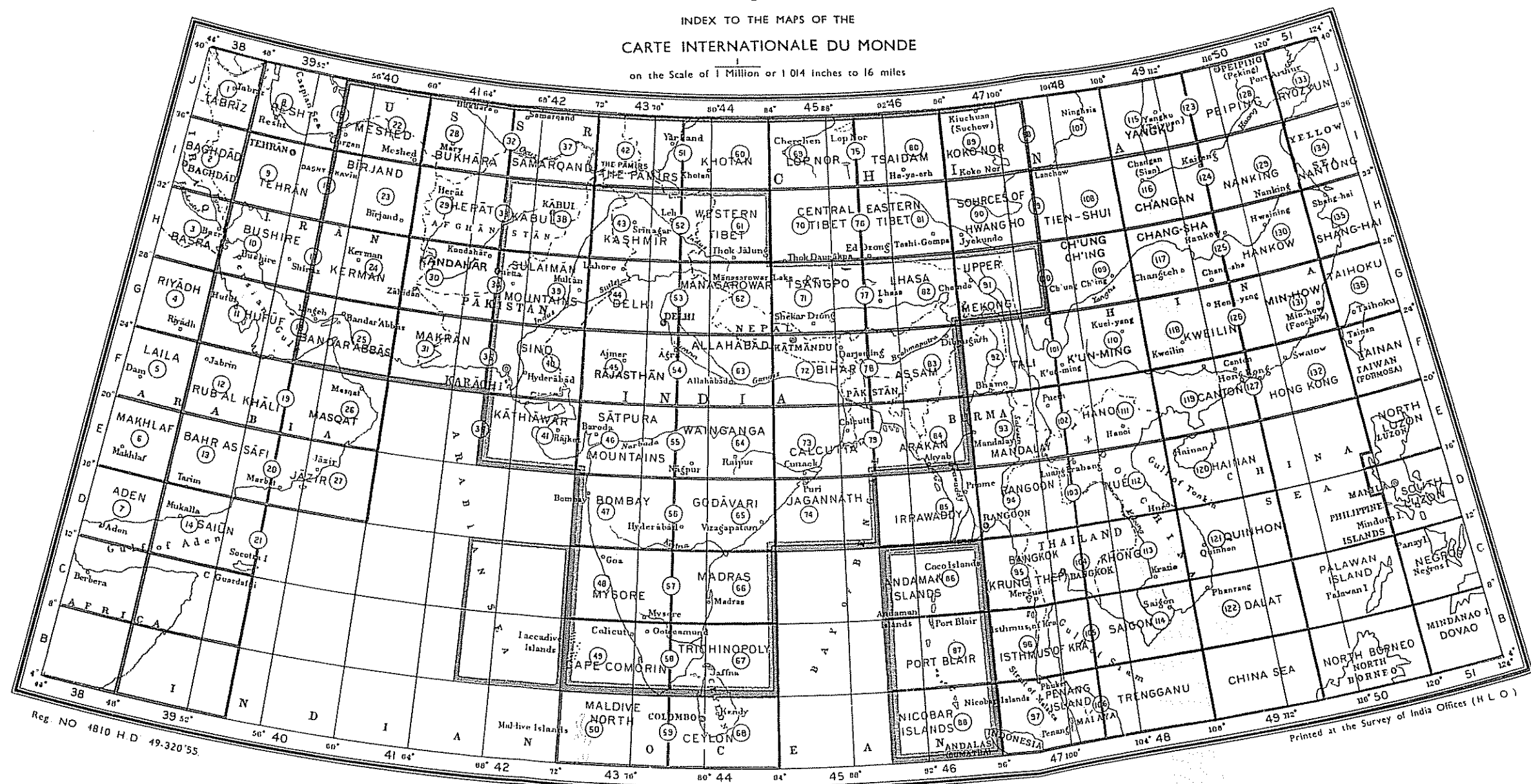
<sup>1</sup> B. G. Gulatee, *Technical Paper No. 7*, published by the Survey of India (Dehra Dun).



Figure 21

INDEX TO THE MAPS OF THE  
CARTE INTERNATIONALE DU MONDE

on the Scale of 1 Million or 1 014 inches to 16 miles



Published under the direction of Brigadier I.H.R. Wilson F.R.I.C.S. M.I.S. (Ind), Surveyor General of India.  
1954.

Scale of Index 1:1,014,000  
Miles 0 100 200 300 400 500 600 700 800 900 1000

This index map is reproduced by courtesy  
of the Survey of India, which supplied the  
negatives required for the purpose.

Most of the sheets shown were issued during the war as the  
Hind 5000 series. They are now in the process of being  
re-converted to the Carte Internationale du Monde style.

The 1/M scale India and Adjacent Countries Series is obsolete; the  
Index is however shown as it forms the basis of the numbering and  
layout of all the standard topographical maps of the Department. This  
series has been replaced by the 1/M Carte Internationale du Monde  
series, the layout of which is shown in red. Each map is referred to by  
the combination of letter and figures opposite to it in the borders with  
the letter N as a prefix to indicate that the map lies to the north of  
the equator. For example the map in which Delhi falls is NH-43.



is most desirable to adopt the same projections for both the topographical and cadastral surveys. Also, due to the inconvenience of there having to be a separate margin for almost every degree sheet, in order to keep the errors in Cassini's projection within tolerable limits, and due also to the non-conformal nature of the projection, it is fast becoming obsolete and is being replaced by some form of conformal projection. The United Kingdom and the United States have already effected the change-over and many other nations have followed suit.

It is therefore desirable to improve and standardize the present methods of cadastral surveys in such countries as India by (a) basing the cadastral surveys on proper trigonometrical data of the national framework, including detail and contours, and (b) adopting the Lambert conical orthomorphic or a transverse Mercator projection (depending on the layout of the country) instead of the present Cassini's projection, or in any case adopting the same projection for both the cadastral and topographical maps of the country.

#### *Sub-item 6 (g) (i)*

It is suggested that the "Interim Specification for the International Map of the World (IMW) on the Millionth Scale Series" reproduced on pages 93 to 97, be accepted and adopted as the standard for the IMW maps, with as little change as possible.

As each participating country is likely to have its own special problems, the specification should be made flexible to a certain extent. It is suggested that it should consist of "Standards", "Recommendations", "Explanatory Notes" and "Tables of Symbols and Lettering".

Differences between the 1913 and 1928 resolutions of the Central Bureau, Carte du monde au millionième and the Survey of India practice in respect of the specification for the IMW series are as follows:

#### 1) Resolution (4) of 1913: Limits, Numbers and References of Sheets

According to the resolution, month and year of compilation should be given under the south-east corner of the border. The Survey of India instead gives the year of the current edition in the north-east margin and indicates previous issues in the south-west margin.

#### (2) Resolution (7): Hypsometric Colours and Contours

- (a) The contour intervals, both for land and sea areas, are different;
- (b) No auxiliary contours are shown;
- (c) Lake beds are not contoured.

#### (3) Resolution (8): Lettering

Lettering of explanatory matter appearing outside the sheet limits is not all in lower case; for example, headings of various indexes in south margin, sheet name, IMW legend in north-west margin.

#### (4) Resolution (10): Conventional Signs and Colours

- (a) No distinction is made between perennial and non-perennial streams;
- (b) According to the 1913 resolution, auxiliary contours should be shown by dotted lines and principal

contours by firm lines. The Survey of India shows all contours by fine continuous lines in "good reliability" areas and by broken lines where height data is insufficient;

(c) According to the resolution, sea and lake-bed contours should be drawn in black, but the Survey of India shows no contours in lake beds, and contours in sea areas are printed in blue;

(d) Soundings in sea areas are shown in blue and not in black as laid down in the resolution;

(e) Telegraph lines are shown in black instead of red;

(f) No special sign is used for denoting large seaports with quay accommodation for ships;

(g) Variation in the surface level of large lakes is not shown by a broken line along the water edge, but perennial water portions are tinted blue and dry portions are shown by blue stipple;

(h) According to the resolution, the name of each feature should be in the same colour as the feature itself. The Survey of India departs from this in the case of road names, which are given in black, while roads are shown in red;

(i) Contours pertaining to ice caps, glaciers and perpetual snow are shown in blue and not in black as laid down in the resolution.

#### (5) Aerodromes

The symbol laid down by the Central Bureau in 1928 is different from the one employed by the Survey of India.

### INTERIM SPECIFICATION FOR THE INTERNATIONAL MAP OF THE WORLD (IMW) ON THE MILLIONTH SCALE SERIES

#### *General Observations*

At an international conference held in London in 1909, it was decided to draw up a standard international map of the world. All sheets were to be prepared on the same projection and the same scale, and were to be uniform in style and symbols.

The proposals put forward were reconsidered at a second conference held in Paris in 1913. The resolutions then passed, modified by various changes that have been introduced at subsequent conferences, are given in these instructions.

The United Nations has set up a Cartographic Office which will study a new specification for the world map coverage, but whether this series will be on the millionth scale or not is yet to be decided. Until this is done, the instructions in this "Interim Specification" will be followed for the production of those IMW sheets covering India which it has been decided to maintain.

This series is intended primarily to cover India with a set of suitable hypsometric maps, that is, maps in which the successive altitudes and depths are indicated by a system of colour tints. An unlayered edition will also be published.

#### *Specifications*

##### *Area of each sheet*

Each sheet is to cover an area of four degrees in latitude by six degrees in longitude.

### Layout, sheet numbering system and sheet names

(a) The limiting meridians of the sheets will be at successive intervals of six degrees, reckoning from Greenwich; the limiting parallels will be at successive intervals of four degrees, reckoning from the equator.

The breaking of margins, without any extension of the graticule to include a special feature, is permissible.

(b) The zones extending from the equator, to 88 degrees latitude on each side, are to be given letters from A to V. The sectors from longitude 180 degrees east or west of Greenwich are to be given numbers from 1 to 60, increasing in an easterly direction.

(c) In the northern hemisphere each sheet will bear a descriptive symbol, composed of the letter N, followed by the zone letter and sector number corresponding to its position: for example, NC 44. In the southern hemisphere the letter S will replace the letter N.

(d) Each sheet will, in addition, bear the name of the locality or most important geographical feature in the area represented. The names selected for the sheets which the Survey of India is continuing to maintain are given in the index to the maps of the Carte internationale du monde (figure 21).

### Projection

The projection should fulfil the following conditions: (a) the meridians should be straight lines; (b) the parallels should be arcs of circles of which the centre should lie on the prolongation of the central meridian.

Lallemand's modified polyconic projection was adopted by the International Map Committee, London, 1909, and is recognized as the international (polyconic) projection for this series. Table 38, Map of Auxiliary Tables, part I, seventh edition, gives the necessary graticule values for plotting.

### Style of map

This series will be published in two styles only: (a) layered; (b) unlayered with stump shading.

The editions will be engraved.

There will be no aeronautical edition of this series, but aerodromes will be shown by a conventional symbol.

### Size

The maps should be printed on sheets of a minimum size of 31.5 by 25.6 inches.

### Colours

The series will be printed in four basic colours: black, red, electric blue and brown. The following auxiliary colours will be used: monastral blue for water areas, green and brown for layer tints.

The items to appear in the various basic colours are indicated in the "Table of Lettering and Symbols for International Map of the World, 1:One million (for reduction by one-fourth)", 1952.<sup>2</sup>

### Hypsometric tints and contours

(a) The contour intervals will be as shown in the altitude scale (figure 22). On the layered edition, the contour values will be printed in metres only, on the unlayered edition in feet only. Heights and depths on both editions will be in both metres and feet.

(b) Minor features of importance, which would not be shown by contours, may be represented by form lines. Small rocky hills may be shown by the symbol for a rocky knob. Such minor features are not to be confined to plains areas but should include prominent peaks in hill ranges that are not shown up by the contouring. Features less than 200 feet in height above the general level of the surrounding country should be omitted.

(c) The hypsometric tints will conform to those of the scale attached to the original 1914 resolutions, modified to suit the contour intervals adopted by the Survey of India. Thus they will be as follows:

Hypsometric tints will not be used above the line of permanent snow, on glaciers, or on lakes and double-

<sup>2</sup> Not reproduced in this report. See pages 96 to 97.

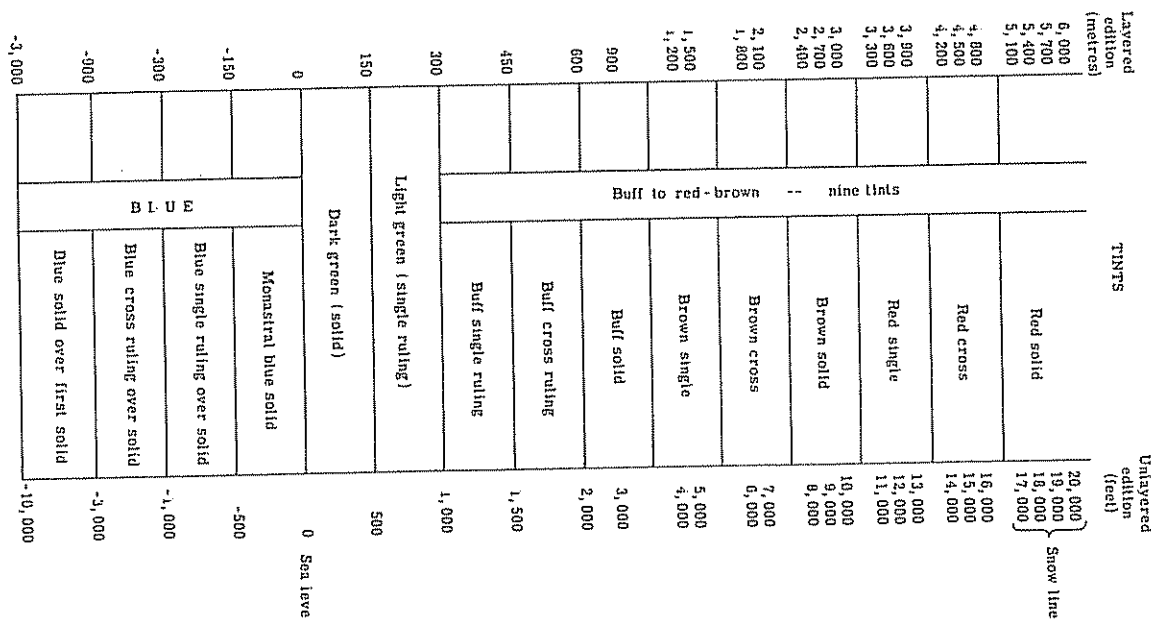


Figure 22. Altitude scale

Contours are shown by figures, layer limits by horizontal lines. Contours will be printed in brown.

ned rivers. They will be carried over marshes, dry portions of lakes and mangrove swamps and mud not on the foreshore. Mud and sand on the foreshore will carry the first sea layer. Swamp on the foreshore will carry the first sea layer if not heavily covered with reeds; if heavily covered with reeds, it will carry the first land layer.

Ice caps, glaciers and perpetual snow will be on a white background printed in blue.

Under-water features will be shown in the same way as land features, that is, by contours at intervals of 9, 50, 300, 900 and 3,000 metres.

The representation of the sea-bed bathymetric contours will be supplemented by soundings, particularly at great depths.

Sea areas will be given a blue wash, darkening with depths; for layers see the altitude scale (figure 22).

On the layered edition, lakes and double-lined rivers will have a monastral blue single ruling over the solid blue wash of the first sea layer as for the second sea layer. The first blue solid will be printed throughout the sea area.

On the unlayered edition, both the sea areas and the lakes and double-lined rivers will have only the first depth tint, that is, monastral blue solid. There will be no layers in the sea on the unlayered edition.

The unlayered edition will be stump-shaded.

*Orders, graticules and their values*

These will be shown as in the border specimen for the International Map of the World sheets on the millionth scale, appendix B.<sup>3</sup>

*Headings*

(a) In upper left margin:

CARTE INTERNATIONALE DU MONDE AU  
1,000,000<sup>ème</sup>

INTERNATIONAL MAP OF THE WORLD 1:1,000,000

(b) Central heading:

Sheet name from the Index to the maps of the Carte internationale du monde on the millionth scale;

(c) In upper right margin, above border sheet number, for example, NC 44;

Immediately above the sheet number, the year of the edition, for example, 1950 Edition (printed in red);

(d) In extreme right corner, above right-hand marginal items, the box for reference data; for example,

Refer to this map as: One M  
Sheet NC 44, First Edition.

On the unlayered edition the word "unlayered" will be entered in the third line of the box for reference data and printed in red.

*Footnotes*

(a) Scales are to be printed in black and centred on the map, showing miles, kilometres and nautical miles, as on order specimen for the International Map of the World sheets on the millionth scale, appendix B.

(b) On the left below the border in the following order:  
Reg. No.

Pronunciation key (see appendix B)

<sup>3</sup> Not reproduced in this report.

## NOTES

Example { Heights are in metres and feet, the latter being in brackets  
Add "and depths" where necessary  
Les altitudes sont indiquées en mètres et en pieds, ces derniers entre crochets  
Compiled, drawn and photo-zincographed by the Survey of India  
Dressée, dessinée et publiée par le "Survey of India"

Edition notes

Price note

Copyright reserved

Box for reference data

(c) On the right side below the border:

(i) Engraved and printed at the Survey of India Offices

(ii) Symbol table

(d) Placed centrally below the scales, the following three indexes in the following order from the left:

First, administrative index;

Second, adjoining sheets;

Third, relative reliability index.

Centrally, below the indexes, special references if any, for example, an imprint indicating the country publishing the map.

Note: "East of Greenwich" will not be entered on either the layered or unlayered editions.

*Right-hand marginal notes*

(i) Index showing lines of equal magnetic variation;

(ii) Diagram showing magnetic variation along the central meridian of the map;

(iii) Altitude scale (metres only on layered editions and feet only on unlayered editions);

(iv) Conversion table, metres and feet;

(v) Colour printing tabs;

(vi) Special notes if any.

For borders, headings, footnotes and marginal items, see the International Map of the World sheets on the millionth scale, appendix B.

*Administrative index*

This will show:

(i) International boundaries;

(ii) Major partitions of country (state boundaries in India), if shown in the body of the sheet.

Country and major partition names will be entered.

*Relative reliability index*

This index will indicate the principal sources of information from which the map is compiled.

*Lettering and conventional signs*

These will be in accordance with the "Table of Lettering and Symbols for International Map of the World 1:1,000,000", 1952.

*Spelling of names*

Spelling should follow the authorized custom of the country concerned until an international system of uniform spelling is adopted by the United Nations Cartographic Office.

### *Edition Note*

(a) (i) An edition note will be entered as a footnote in the south-west margin, indicating the dates of previous issues, and should take the following form: "Previous issues: 1919, 1926 and 1936".

(ii) The edition legend will be entered in the north margin above the sheet number, with date, as "1941 Edition".

(iii) In the boxes for reference data in the north-east and south-west margins, the legend should specify the number of the edition, as "Fourth Edition".

(b) The date of publication to be given in the map should be:

(i) For maps that are not yet engraved, the year of photography in the reproducing office;

(ii) For maps that are engraved, the year in which the combined proof is finally approved.

### *Conventional Signs, Colours and Details*

#### *Printed in blue*

Hydrographic features and their names will be in blue. All line detail, including names, will be printed in electric blue. Monastral blue will be used for all washes and tints.

(i) Rivers and streams should be selected to give a correct impression of the drainage. Rivers of less than about 1,000 yards in width will be drawn single line. Streams of less than eight miles in length will usually be omitted.

Unsurveyed streams will be shown broken.

Non-perennial beds of double-lined rivers and lakes will be shown by a stipple printed in electric blue.

(ii) Wells and springs will be shown in desert areas only.

(iii) Rapids and falls will be shown only when a hindrance to navigation or a possible source of power or when very well known.

(iv) Dams (including weirs and anicuts) will be shown only when important.

(v) Steamer routes will include motor launch services. Steamer routes in the ocean will not be shown. They will be shown on internal waterways.

(vi) Canals will be shown only when more than one-quarter of a mile in length.

(vii) Lake, marsh and mud: As a guide a non-perennial lake of four square miles, a lake of one square mile with one-quarter square mile perennial or a completely perennial lake of one-half square mile will be shown. Marsh, mud and swamp and mangrove swamp will be shown.

(viii) Coast line, including that of islands, will be shown by a thick line. Where an inlet reaches a width of five miles, the deep blue inland water tint will be shaded off to the light sea tint. The thick blue line will be carried up each side of the inlet to this point.

Actual shapes of rocky headlands, and the like, should be carefully shown.

(ix) Tidal arrows and arrows showing direction of flow will be shown.

(x) Water pipelines will be shown only when they are twenty miles or more in length.

(xi) Bathymetric contours and their values, including the nine-metre contour, will be shown. This nine-metre contour will not be shown on the altitude scale. Sea depths will be entered in metres with the value in feet printed below. They will be taken from admiralty charts.

(xii) Coral reef and sand on foreshore will be shown.

(xiii) Glaciers and snow contours will be shown.

#### *Printed in red*

Roads and edition legend in the north-east corner above the sheet number will be printed in red.

(i) Roads will be divided into three classes:

First-class (Main)—Metalled and surfaced all-weather motorable roads;

Second-class (Secondary)—Unmetalled roads, and in sparsely inhabited or desert areas where there are no roads with a definite formation, fair-weather motorable cart-tracks;

Third-class—These will be shown only in areas where the normal means of transport is by country cart or pack. For this purpose, transport by pack is understood to include that by elephant, camel, mule and similar animals, and also by coolie. Tracks which are fit for nothing but coolie transport will be shown only where there are no other means of transport and where they are of sufficient importance.

Note: Roads will be broken for all unbridged crossings of double-lined streams. Where there is a permanent bridge over a double-lined stream or railway, this will be inserted. Bridges over single-lined streams will not be shown, but the road will be drawn right across the stream.

(ii) Only important passes will be shown on roads of all classes. Roads will be broken for the pass symbol.

(iii) Only those tunnels over one-quarter of a mile in length will be shown, the symbol being slightly exaggerated where necessary.

(iv) The legend "restricted" and "unlayered", when applicable, will be printed in red.

(v) Aerodromes controlled by the Director-General of Civil Aviation in India and the Indian Air Force will be shown by a conventional symbol and printed in red. The symbol will consist of a circle one-tenth of an inch in diameter. The centre should fall in the correct geographical position of the aerodrome.

The official name of an aerodrome need be entered near the site only when the town or the village after which it is named is not selected for entry or when it is located too far away. The name when entered will be printed in black.

#### *Printed in black*

The following features will be printed in black.

(i) All railways should be shown. All stations will be shown on the side of the line on which they are situated.

Railways will be divided into four classes:

Broad-gauge, with two or more tracks;

Broad-gauge, with single track;

Metre-gauge;

Narrow-gauge (should have the gauge typed along the symbol).

Important tramways will be shown by the railway symbol for narrow-gauge railways, with the name entered along-side. Information regarding railways under construction will be taken from any reliable source, and such railways will be shown by the appropriate symbol.<sup>4</sup>

Only those tunnels over one mile in length will be shown.

Note: Bridges over single-lined streams and canals will not be shown. In all other cases they will be shown, for example, a railway over a road or double-lined stream.

(ii) Town and village sites will be entered only for those places which are to be named on the map. Where the

<sup>4</sup> See "Table of Lettering and Symbols for International Map of the World, 1:1,000,000".

le permits, sites should be shown in plan. There should be five different symbols to distinguish their relative administrative importance:

First order—Capitals of countries;

Second order—Major cities of administrative importance (headquarters of states in India);

Third order—Third in order of administrative importance (headquarters of districts in India);

Fourth order—Other towns (headquarters of Tahsils or divisions of districts in India);

Fifth order—Small towns and villages.

The following will be shown by the fifth-order symbol with the letter "B" and the name: DB (Dak bungalow), I (Rest house), IB (Inspection bungalow) and TB (Travellers' bungalow).

Large surveyed sites (for example, cities of the size of Delhi, Calcutta and so on) will be broken into blocks corresponding with main through streets, but the breaks for the letter should be narrow compared with the thickness of a metal road symbol. Roads should stop at the edge of a site in all cases. Railways and canals should be drawn rough the site, the hachuring of the site being interpreted for the symbol. The relative importance of these sites on other grounds will be shown by different sizes of lettering. The following sizes of type are prescribed:

First size—Capitals of countries and major cities of administrative importance (headquarters of major states in India);

Second size—Other large cities of administrative importance (headquarters of other states in India);

Third size—Towns with population over 1,000,000;

Fourth size—Towns with population over 50,000;

Fifth size—Towns with population over 20,000;

Sixth size—Towns with population over 10,000;

Seventh size—Towns and villages with population over 5,000;

Eighth size—Towns and villages with population below 5,000.

Names of minor partitions (districts in India) should invariably be spaced horizontally across the area to which they refer.

(iii) [The paragraph concerning boundaries was withdrawn.]

(iv) Telegraph lines and post and telegraph offices should be shown when considered necessary. Important telephone lines will also be shown where necessary by the symbol for telegraph lines and with the descriptive remark "Telephone line" entered alongside.

The symbol for a telegraph line when it is coincident with a road or track will be shown by black ticks only, always entered conventionally on the north and east sides of the detail. In the case of the tracks, the ticks should be drawn in the centre of each bar.

(v) Submarine cables will be shown by fine continuous lines in short lengths radiating from the terminal points, with the entry "Submarine cable" (with date if available) and destinations.

(vi) Only those oil pipelines which are twenty miles or more in length will be shown.

(vii) Only major power lines will be shown, that is, those from power stations to major distributing stations. To be confined to those above ground.

(viii) All important mines, which may often be grouped under one symbol, will be shown. The name of the substance mined is to be entered.

(ix) Only forts of historical interest or important as landmarks will be shown.

(x) All lighthouses will be shown.

(xi) All wireless stations if they are topographically prominent will be shown.

(xii) Oil wells will be shown by the well symbol in black with the word "Oil" against the symbol.

(xiii) Ruins will be entered for ruined sites which are famous. If the ruin is a single building, it will be shown only if it is very well known and at some distance from a site.

(xiv) Caravan halting places will be shown only along definite and well-known routes in sparsely inhabited areas.

(xv) Missions, mosques and temples will be shown in areas where such buildings are important but not general. They may be entered in other areas, when they are at some distance from any site and are very well known.

(xvi) An aerial ropeway will be shown only when it is an important means of transport and not less than twenty miles in length.

(xvii) Only those anchorages which are used for trade and not for shelter and which are not less than four miles from the nominal port will be shown.

(xviii) All geodetic triangulation stations and selected stations of minor triangulation will be entered.

(xix) Heights above mean sea level will be shown in metres, with the value in feet within brackets printed below. They are to refer to ground level. Height dots should be omitted when the exact spot is not indicated, as in the case of heights for towns.

(xx) Query marks will be entered along unreliable details or names.

*Sub-item 6 (g) (iii). Limits of mapping responsibility for the Carte internationale du monde (CIM) au millionième series*

In 1938 the Survey of India agreed to compile, draw and print the sheets on the millionth scale covering the areas bounded by a purple line on the index (figure 21).

Because of the Second World War, which lasted from 1939 to 1945, it was not possible to complete and print these maps in accordance with the specification drawn up by the Central Bureau of the International Map of the World on the Millionth Scale in Paris in 1913. Considerable progress was made, however, and many of the sheets covering India were engraved on copper, but the specification was not entirely in agreement with the international specification. In 1949 it was decided by the Survey of India to concentrate on completing the sheets on the millionth scale for those areas bounded by a green line on the index. An interim specification was drawn up and action is being taken to complete the maps accordingly.

India will take up the preparation of the additional sheets for the areas bounded by a brown line on the index.

As the other governments may now be prepared to take up the preparation of some of the sheets covering their territories, the final division of mapping responsibility for CIM sheets should be made at the conference in Mussoorie, India, in February 1955.

*Sub-item 7 (i). Procedure for obtaining from adjacent countries information and mapping material in cases where the international mapping responsibility of one country extends over the territory of another country*

When a country which is allotted a sheet for mapping and printing containing a portion of an adjacent country begins the compilation of the sheet, it should inform the adjacent country concerned and request it to supply the material for the sheet.

The adjacent country should compile and complete the mapping of its territory on the millionth scale in

colours but without layer tints, in accordance with the final specification for the CIM series, and send the portion required for completing the sheet to the mapping organization of the country responsible for the sheet concerned.

All differences along the common edge should be adjusted by the country mapping the sheet with the approval of the adjacent country.

Full colour proof copies of the map should be sent to the adjacent countries concerned for scrutiny and should be returned before final printing.

## COMMUNICATION RECEIVED FROM THE INTERNATIONAL TELECOMMUNICATION UNION

(The original text, taken from a letter dated 3 October 1954,  
appeared as document E/CONF.18/A/L.12)

The International Telecommunication Union has interest in cartography from two points of view, namely in regard to the adequacy of (1) the maps which are published by the General Secretariat and the maps which are consulted by the permanent organs of the Union and particularly by the International Frequency Registration Board in connexion with its technical studies...

*sub-item 6 (b) (iv) and sub-item 6 (c)*

As regards (2) above, the Union has a general

interest in improvements in map-making, particularly in the greater part of the areas which fall within the purview of the forthcoming Conference. It also has a particular interest in any steps which would lead to uniformity in transcription of geographical names, especially with reference to countries where Latin characters are not in general use, and also in the accurate delineation of boundaries, both national and provincial.

# PRESENT STATUS OF CARTOGRAPHY AND RELATED SURVEYS IN JAPAN

by

*Dr. Naomi Miyabe*

*Chief Inspector, Geographical Survey Institute*

(The original text of this paper appeared as document E/CONF.18/A/L.13)

## RECENT GEODETIC WORK

Recent geodetic work, especially triangulation and precise levelling, has been carried out with two objectives. One is to obtain accurate geodetic positions of the triangulation points and heights of bench-marks for control of cartographic work; the other is to measure horizontal and vertical movements of the earth's surface caused by earthquakes or by orogenic sources.

### *Triangulation*

Accompanying the destructive 1946 earthquake, conspicuous deformations of the earth's crust occurred on the Pacific coast of Shikoku and of the Kii peninsula facing the epicentre. The revision of triangulation extended over forty-seven principal first-order points, sixty-six supplementary first-order points, 175 second-order points and 878 third-order points.

Another destructive earthquake occurred on the Japan Sea coast on 28 July 1948. In connexion with this earthquake's effects, triangulation was first revised with regard to seven first-order points, eight supplementary first-order points, sixteen second-order and twenty third-order points. The revision was then extended to the adjoining area in which nineteen first-order points are included.

Revision of the first-order triangulation was also carried out in the area that might have been deformed by the 1952 Hokkaido earthquake. In this area, ten first-order points are distributed.

### *Levelling*

The vertical deformation of the earth's crust associated with the 1946 Nankai earthquake was measured by re-running the precise levels along the line extending about 7,000 kilometres through the area disturbed by the earthquake. The change in height of the bench-mark, which was found to have amounted to a maximum of seventy centimetres, both for upheaval and subsidence, was especially notable along the Pacific coast facing the epicentre of the earthquake.

In the case of the 1948 Fukui earthquake, vertical deformation of the earth's crust was also investigated by means of precise levelling. Similarly, after the 1952 Hokkaido earthquake, the lines were resurveyed to

the extent of about 1,100 kilometres all along the Pacific coast of the island and inland. As the result of these surveys, the ground near the Erimo promontory was found to have risen by about twenty centimetres relative to the surrounding area.

In some parts of the cities of Tokyo and Osaka, and in several other regions, local sinking of the earth's surface is notable, the rate even exceeding five centimetres per year at several places. This sinking is, however, not associated with the occurrence of earthquakes. In order to watch the progress of the sinking, precise levelling has been repeated frequently. The results of triangulation and precise levels have been or will be reported in the *Bulletin of the International Association of Geodesy*.

Besides the revision of precise levellings, the establishment of the lines of the second-order levels has been going on. This is based on earnest requests from industrial and civil engineering circles. The total length of the lines of the second-order levels projected is 10,000 kilometres, of which 2,000 kilometres have been finished.

### *Deflection of the Vertical*

Deflection of the vertical was measured at 123 points, during the period from 1939 to 1953, by the Geodetic Commission of Japan and by the Geographical Survey Institute. Five points were added in 1954.

### *Occultations*

Preliminary experiments to determine lunar occultations by means of photoelectric multipliers have been made at several pairs of stations on the equal limb line by members of the Tokyo Astronomical Observatory. The single observation of occultation by using a photoelectric multiplier is now being carried on as routine work. The advantage of the photoelectric multiplier consists in the fact that even stars of the ninth magnitude can be observed by means of it, and this sensitivity makes frequent observation of occultation possible. Observations of this kind number several dozen a year, on an average.

### *Gravity*

By the Second World War, 122 pendulum measurements had been taken in Japan proper, 21 in Korea



in Manchuria, 10 on South Sea islands, 13 in Formosa and 61 on the neighbouring seas. The distribution of gravity anomalies deduced from these measurements is to be related to the surface features of the earth, especially on the Japan trench.

Since the war, two outstanding developments have taken place in this field of study in Japan. One is the measurement by means of various gravimeters, the other the completion of two sets of three-quartz-pendulum apparatus for standard gravity measurements.

Two Worden gravimeters and two North American gravimeters were imported from the United States, and detailed gravity measurements throughout Japan were begun. Of these, one Worden gravimeter and one North American are used for geophysical exploration. C. Tsuboi of the Earthquake Research Institute, Tokyo University, measured gravity by using a Worden gravimeter at about 3,000 points in Honshu, Shikoku and Kyushu; the experts of the Geographical Survey Institute used the North American gravimeter at about 1,500 points in Hokkaido and northern Honshu.

Thus, in all, 4,500 gravimeter measurements have been made by which to investigate the underground structure of the country.

The two sets of apparatus completed by the Geographical Survey Institute consist in each case of three isochronous fused silica pendulums. Two outside pendulums, *A* and *C*, are swung in opposite phases while the middle one, *B*, is hung freely at rest. The period of oscillation of two imaginary pendulums (*A-B*, *B-C*) is determined by receiving the second-to-second wireless time signals JJY. An accuracy of  $\pm 0.2$  milligal is obtained. The Geographical Survey Institute is now trying to attain an accuracy of  $\pm 0.1$  milligal, by using a quartz clock.

In accordance with the resolution at the Brussels Meeting of the International Union of Geodesy and Geophysics, the following places have been selected as Japan's national fundamental gravity stations, and the gravity measurements at these stations have been made by means of the Geographical Survey Institute pendulums with utmost care. The values are given by use of the Potsdam system.

Table 4. Gravity Measurement at Five Stations in Japan

Place	Gravity (gals)		Latitude and longitude	Height (metres)
Sapporo	980.4901	$\pm 0.0002$	43°04'02"N; 141°20'08"E	16.04
Mizusawa	980.1615	$\pm 0.0002$	39°07'09"N; 141°08'02"E	60.74
Kakioka			36°13'08"N; 140°11'05"E	30.76
Kyoto	979.7215	$\pm 0.0002$	35°01'06"N; 135°47'02"E	60.82
Kumamoto	979.5632	$\pm 0.0002$	32°48'08"N; 130°43'08"E	22.84

#### RECENT GEOMAGNETIC SURVEYS

Until the Second World War, the geomagnetic survey in Japan had been carried out by the Hydrographic Office. The distribution of geomagnetic elements has been revised five times—that is, every ten years since the survey was first completed in 1903.

After the war, the Geographical Survey Institute constructed a new magnetometer<sup>1</sup> for geomagnetic surveys, and began in 1950 a systematic geomagnetic survey over the whole of Japan. For this twenty basic and sixty-two ordinary first-order magnetic points were selected, where special geodetic monuments were installed for expediency in remeasuring.

The distribution of geomagnetic elements of the period 1950 was obtained, in which the distribution of horizontal intensities was deduced on the assumption that  $\text{rot } H=0$ . This is equivalent to assuming that there is no systematic vertical current.

In 1952, the second-order magnetic survey was begun; it is aimed at obtaining detailed features of the distribution of geomagnetic anomalies. For this 181 points were occupied in Hokkaido. The results of these surveys may serve as basic data for geophysical explorations and topographical surveys.

<sup>1</sup> GSI magnetometer, constructed by I. Tsubokawa.

#### TOPOGRAPHIC MAPS

Japan has completed the mapping of 1:50,000 scale topographic maps covering its entire land area. At present, the topographic work of the Geographical Survey Institute is concentrated upon preparation of 1:25,000 scale topographic maps and revision of 1:50,000 scale maps. Surveys for larger-scale topographic maps, such as 1:10,000 scale maps, are also being continued. Efficiency is attained by using aerophotographs and plotting instruments such as the Stereoplanigraph and Multiplex.

The 1:50,000 maps hitherto issued are of one colour. These will be replaced by multicolour maps in the near future. Efforts are also being made to adopt international symbols for medium-scale maps such as 1:50,000 scale maps. In our opinion, however, there must be several characteristic symbols in reproducing the surface features of the land in Asia, including Japan.

#### NATIONAL LAND SURVEY

The national land survey was first begun in 1951, following the coming into effect of the National Land Survey Law in June of that year. At the beginning, it aimed merely at base point surveying, but later other surveys such as a cadastral survey (started in 1952), a water survey (1953), and a land-classification

survey (1954) were also begun. Thus, a complete system of national land surveying has now been established.

#### *Progress of the National Land Survey*

##### *Base-point surveying*

This survey is being conducted by the Geographical Survey Institute in eight regions separately, in each of which there is a branch office. According to the first-stage programme, about 40,000 base-points are scheduled to be established. By the end of fiscal year 1953, 10,530 of them had been established and an additional 2,400 were scheduled for fiscal year 1954. These points are distributed in twenty-nine prefectures, including Hokkaido.

##### *Cadastral survey*

According to the first-stage programme, an area of 105,000 square kilometres is to be surveyed. Of this area, 700 square kilometres was surveyed by the end of fiscal year 1953 and 630 square kilometres was scheduled to be surveyed in 1954. Towns and villages where the cadastral survey is under way are attempting to use the survey results for various projects, such as land improvement, changes in land ownership (exchange, separation, merger, and so on), and rural development programmes. Where the survey has been completed many towns and villages are actually successfully carrying on their projects based on the survey results.

##### *Water survey*

The water survey began with basic studies on precipitation, stream flow, water quality, subterranean

water, and other factors, through field surveys, with a view to establishing the necessary survey net. The survey is now being conducted along such rivers as the Mogami, the Kitakami, the Kinu, the Ohta, the Joganji and the Chikugo. Of these, the basic work on the Kinu River survey has been completed, and the project has entered the stage of permanent observation. According to the programme, the basic survey is scheduled to be completed before fiscal year 1960 along all of the principal rivers flowing through districts where multiple-purpose development programmes are to be carried out.

##### *Land-classification survey*

The land-classification survey consists of two parts: a basic survey and a detailed survey. The basic one, to be performed in reference to 1:50,000 scale maps, includes a geomorphological survey, a surface geological survey, and a soil survey, which were scheduled to be completed, in principle, within five years from 1954. The basic survey was scheduled to be performed for an area of 1,000 square kilometres during fiscal year 1954, and for an area of 104,700 square kilometres during the four years following.

The detailed survey is performed by town and village authorities in connexion with the cadastral map, and, consequently, is scheduled to be carried out in the order of completion of each part of the cadastral survey, in the year following its completion. In fiscal year 1954, however, an area of 25 square kilometres was taken as a sample area for detailed survey. In 1955 and thereafter, the detailed survey is to be done in conformity with the execution of the cadastral survey.

# INSTRUMENTS AND METHODS USED TO PREPARE MEDIUM-SCALE MAPS OF AVERAGE PRECISION IN MINIMUM TIME

by

*Institut géographique national, Paris, France*

The original text of this paper appeared in French as document E/CONF.18/A/L.14 under the title "Instruments et méthodes les plus propres à assurer l'exécution rapide de levés cartographiques de précision moyenne à une échelle de l'ordre du 1/100,000 par l'exploitation des photographies aériennes dans les pays qui ne sont pas encore pourvus de cartes régulières").

The remarkable progress in aerial photogrammetry during recent years in the development of instruments and in research has made possible the employment of new processes, permitting rapid production of moderately accurate maps on a scale of about 1:50,000 or 1:100,000. The National Geographical Institute, after many years' study, has reached certain conclusions which it would like to put forward.

The sequence of operations involved in the making of a 1:50,000 or 1:100,000 map, using present equipment, might be as follows:

(a) Aerial photographic coverage;

(b) Establishment in the field of a skeleton control network: for horizontal control, a normal first-order geodetic survey, which may in some cases be replaced by an astronomical control net; for vertical control, a large-mesh precision level net;

(c) Limited photogrammetric preparation in the field in conjunction with "special checking" (interpretation of aerial photographs, and so on);

(d) Determination of the points required to orient each individual pair of photographs in a plotting instrument, that is, (i) photographic triangulation, to obtain the detailed planimetric control, and (ii) photogrammetric traversing or aerial triangulation on a first-order plotting instrument, to obtain the vertical control;

(e) Plotting on a second-order plotting instrument.

The various operations are considered in further detail below.

## STEREOSCOPIC AIR PHOTOGRAPH COVERAGE

The quality of the photographic coverage directly affects all subsequent operations. It must be carried out by a specialized unit trained in aerial survey work and using first-class equipment. It should employ long-range aircraft capable of carrying out regular photographic missions at altitudes of between 6,500 and 8,000 metres; automatic mapping cameras, preferably using plates, in view of the subsequent aerial triangulation, and fitted with wide-angle, short-focal-

length lenses; and airborne instruments, including statoscopes and radio-altimeters, capable of recording data such as variations in the aircraft's altitude, tilt of camera axis and flight height above ground. If these data are known, the accuracy of the results of the aerial triangulation can be increased and fewer ground control points will be required. The data are not, however, absolutely essential.

The photographic coverage must be vertical (tilt less than about two degrees). Panoramic exposures of the "Trimetrogon" type are unacceptable since, although valuable for information purposes, they cannot easily be used for map-making and surveys of uniform quality cannot be made with them.

If the photographs are to be used efficiently to make small-scale maps (1:100,000), they must themselves be on a small scale (in practice, they cannot well be less than 1:60,000 since otherwise it is difficult to identify certain fine details which must be shown even on a small-scale map. The pictures must be of the highest possible definition.

As a general rule, every photographic mission should cover a ground area of one degree of longitude by one degree of latitude, but there is no reason why the area covered should not be larger. It may be useful, especially when the terrain is difficult, to end the photographic strips at main lines of communication, as this makes the ground work easier.

The strips of photographs covering the area should as far as possible be straight and parallel with each other (60 per cent forward overlap and 10 to 15 per cent lateral overlap). Furthermore, in photographic flights, it is important that the aircraft should be navigated to fly steadily, straight and level, at a practically constant height, and that drift should be properly corrected. Gaps in the strips must be avoided.

## BASIC CONTROL NETWORK

### *Planimetric Control*

In areas for which a first-order geodetic triangulation already exists, the network of reference points formed

by it will be sufficient. In areas for which no geodetic survey exists, a network of evenly spaced astronomical points (at intervals of forty to fifty kilometres)<sup>1</sup> may be made, and is a very economical solution. At greater cost, a network of points determined by modern methods of trilateration based on radar may also be considered (average length of sides approximately 100 kilometres). This solution is recommended for areas where there is danger of considerable deviation from the vertical.

#### *Vertical Control*

In ordinary surveying, the specifications regarding accuracy are much stricter for elevation than for planimetric reference points, since slight differences in level govern the flow of water. It is therefore necessary to lay out a large-mesh precision level net, the reference heights of which will, where possible, be used in all subsequent measurements, whether for general surveys or specific projects connected with irrigation or use of water-power. The net should follow the main lines of communication.

A net of this kind can be established relatively cheaply. To do annually 8,000 to 10,000 kilometres of lines of communication requires neither a large staff nor very much material.

#### PHOTOGRAMMETRIC PREPARATION AND SPECIAL CHECKING<sup>2</sup>

Until recently it was still necessary to establish four to six ground control points for each pair of photographs, but the development of aerial triangulation methods makes it possible to reduce the number of vertical control points considerably. Ground surveyors must establish a secondary network of control points for which only the elevation is required within the large meshes of the precision level net. It must be regularly spaced, with one control point approximately every fifteen kilometres. The points, which must be identifiable on the photographs, may be anywhere within the working area. Furthermore, the spacing given is by no means essential. It gives vertical accuracy the same as that of an ordinary survey on a scale of 1:100,000 with a vertical interval of twenty metres (mean error five to six metres; 90 per cent of errors under ten metres), but it may be increased in areas which are difficult of access or of little interest. In this case, it will not be possible to ensure such a high degree of accuracy, but the control provided by the subsequent aerial triangulation will still be uniform enough to ensure correct representation of the relief, which is the primary requirement.

A rapid reconnaissance of the ground is in any case still necessary if the maps produced are to be accurate and complete. Some details that appear on the photographs but cannot be interpreted satisfactorily must be identified on the spot; other details not shown on

the photographs (springs, roads or tracks hidden by vegetation, for example) have to be plotted on them, and information about the condition of roads and tracks, administrative boundaries and place names has to be indicated.

The ground surveyor is no longer required to establish a considerable number of reference points which are identified on the photographs. He may arrange his route to suit the special check to be carried out, the checking being to some extent his primary task.

As a general rule, elevations are obtained by barometric levelling and are sufficiently accurate (mean error about four metres) provided certain strict rules are observed. (For instance the mercury or aneroid barometers used should be carefully calibrated and checked by measuring the differences in the readings of recording barometers set up at fixed points of known elevation and portable barometers).

#### DETERMINATION OF THE POINTS REQUIRED TO ORIENT EACH PAIR OF PHOTOGRAPHS

##### *Planimetric Control*

The planimetric control is established with sufficient accuracy by radial-line slotted-template triangulation based on the planimetric control network described previously. This triangulation method is simple and rapid, requires inexpensive material and gives good results, provided the terrain is not very hilly and the camera axis has been kept vertical during exposure.

Certain variants on this method now being tested at the National Geographical Institute, using information given by traversing the pairs on a first-order plotting instrument, promise to give greater accuracy with a less dense basic network and to make it possible to extend the method even to very mountainous country.

##### *Vertical Control*

This control is obtained by aerial triangulation, using the results of the radial-line triangulation, elevations observed on the ground and, where available, data from recording instruments mounted in the aircraft. The process calls for high-precision plotting instruments which must be easy to operate and adjust.

Using the method employed at the National Geographical Institute, about 100 pairs of photographs a month can be traversed in a Poivilliers type B stereotopograph. An area of 10,000 square kilometres can be dealt with on a single instrument in less than five months.

The adjustment of an assembly of this size can be done quickly and simply by a mechanical process not unlike slotted-template triangulation which has recently been developed at the National Geographical Institute. The purpose of this adjustment is to obtain uniform elevations of the spot heights common to two adjacent strips, and it provides in every case a satisfactory degree of uniformity and yields a degree of precision which increases with the density of the barometric reference point network.

<sup>1</sup> Or even more, if tests now in progress give the expected results.

<sup>2</sup> The French term is *précomplément*.

## PLOTTING

Plotting may be done on a second-order instrument designed to facilitate flexible and quick positioning. The positioning may be roughed out on the basis of information given by traversing the pairs in the first-order instrument. For ground of average ruggedness and low-density planimetry, the rate of output may exceed two square kilometres per hour, so that one or six second-order instruments can keep pace with one first-order instrument working on aerial triangulation.

## CONCLUSIONS

Through aerial photogrammetry it is possible to make rapid average-precision map surveys on a scale of the order of 1:50,000 or 1:100,000. The methods selected must be such as to reduce the long and costly operations on the ground to a minimum and accordingly make full use of the possibilities offered by aerial triangulation.

The use of these new methods requires:

- (a) First-class coverage with vertical stereoscopic photographs, which must be obtained by a specialized unit trained in air survey work, using first-equipment;
- (b) Use of plotting equipment comprising:
  - (i) First-order instruments for aerial triangulation;
  - (ii) Second-order instruments for the actual plotting, one or six of them being needed to keep pace with one first-order instrument.

The considerations discussed above are not purely theoretical. In recent years the National Geographical Institute, which has to map enormous areas of the overseas territories of the French Union, has developed out the methods recommended, developed the equipment needed to carry them out, and trained staff to use the equipment.

The Institute now has:

- (a) A group of photographic squadrons, the crews of which have acquired much experience in cartographic photography. For overseas work, they use 17's modified for aerial photography and Poivilliers OM automatic cameras using 18×18 centimetre plates and fitted with Aquilor wide-angle lenses with focal length of 125 millimetres. During 1954, these crews were able to photograph over two million square kilometres in widely different territories (North Africa, the Sahara, French West Africa, French Equatorial Africa, Indochina, New Caledonia) and under condi-

tions which were difficult (unmapped areas or areas where the number of days suitable for photography is extremely small).

- (b) A section specializing in aerial triangulation work and equipped with five Poivilliers SOM type B stereotopographs for small-scale aerial triangulation work. It can deal with 120,000 square kilometres per year.

- (c) An overseas processing section equipped with thirty second-order plotting instruments (Poivilliers SOM type D stereotopographs) capable of keeping pace with the aerial triangulation work. Plotting is carried out on a scale of 1:50,000, which is close to the scale of the negatives. The vertical interval is twenty metres or twenty-five metres, depending on the territory.

The National Geographical Institute has also worked out a method of preparing original manuscript by which the plotted tracings on the scale of 1:50,000 can be used for the rapid preparation of maps. Production of a map on a scale of 1:100,000 requires:

- (a) Ink drafting, including the insertion of conventional signs on the stereo-tracings;
- (b) Reproduction of these tracings and their assembly in complete sheets;
- (c) Preparation of a zinc on the same scale as the fair drawing and printing on the drafting medium in non-actinic blue;
- (d) Fair drawing for colour-separation;
- (e) Preparation of printing plates.

Operations (a), (b) and (c) above can be eliminated by colour-separation, by drawing directly from the pencil tracings, on a thin, transparent but scale-stable plastic base (Astrafilm 0.12 millimetre thick).

The titles are printed on thin strip-film and stuck on the black plate.

The printing plates can be made from the fair drawings by ordinary photomechanical reproduction.

Using this method, a 1:50,000 map in four colours (black, blue, brown and green) of a special kind known as the "1:50,000 overseas map" can be published within a few months of completion of the plotting. Great care is taken in reproducing the vegetation, which is often one of the main features in economically under-developed areas.

Using this drafting method, thirty to forty draftsmen can prepare about 130 sheets on the scale of 1:50,000, representing a ground area of close to 120,000 square kilometres, each year.

# RECENT PROGRESS IN CARTOGRAPHY AND INTERESTING TECHNICAL DEVELOPMENTS IN THE UNITED STATES

*submitted by the  
Delegation of the United States*

(The original text of this paper appeared as document E/CONF.18/A/L.15, under the title "Recent United States Progress and Interesting Technical Developments in Cartography")

## Cartographic Progress

### TERRAIN MODELS

Mass reproduction of terrain models has become a reality in the United States, with the adoption of the principles of vacuum forming, and using thermoplastic material as a reproduction medium. Opaque white polyvinyl chloride sheets of this material are printed lithographically from standard press plates used to print paper maps. These preprinted maps are then formed, by heat and vacuum, over a male mold, which has been reproduced from a terrain model constructed to correspond to the topographic detail of the map.

This new process lays greater emphasis on the accuracy of the original model and necessitates modification of old, and development of new, techniques, equipment and materials for model construction. Pantograph routers, of German design, have been adapted to cutting the three-dimensional contour base from an acetate laminate. Low-expansion plasters are used for casting, from this base, a step positive mold. The landforms are developed by carving away the step edges. From this original model, a negative mold is cast and, from the negative, a positive mold which is used for the forming operation. An optical device, which permits orthographic projection of map information on to the model surface, has been developed specifically for checking the horizontal accuracy of the model. The vacuum-forming equipment has also been constructed. These new processes make possible the production of tens of thousands of plastic relief maps annually.

### GEOLOGICAL MAPS

The publication of aggregate geological mapping has progressed at an increasing rate. The primary objective of the United States geological mapping is to provide information for exploration and development of minerals, mineral fuels, and ground water resources, and to provide geological maps needed in planning and development of industrial and defence areas.

### SOIL MAPS

The first organized mapping of soils in the United States began in four widely scattered areas in 1899.

From that modest beginning a continuing program has provided maps for approximately 1,647 areas during the past fifty-five years. Soil maps are used by planning technicians in soil conservation districts as a basis for sound farm and ranch conservation plans. In addition, they are found to be useful in the organization and synthesis of research, in agriculture extension programmes, in land appraisals as bases for loans and tax assessments, and in supplying relevant soil information needed by engineers in highway and airport construction. About 350 million acres of land that are adequate for the above purposes have been covered by soil mapping. There is an additional area of 150 million acres for which maps are nearly adequate but which will require some reworking.

In the past two years thirty-one soil survey reports, consisting of map and text, were published, bringing to 1,647 the total number of surveys published since the programme was started in 1899. Published soil maps for this period include approximately 12 million acres (48,563 square kilometres) of detailed survey and approximately 14.1 million acres (57,047 square kilometres) of reconnaissance survey.

The United States has continued its programme for providing adequate nautical charts to United States merchant ships in all oceans of the world, giving special emphasis to coverage of areas with ports having significant volumes of United States maritime trade. With a view to meeting more fully its obligations to provide for the safe navigation of United States vessels, the United States extended its operations beyond its traditional broadcast and "Notice to Mariners" services into the fields of ice and ocean wave forecasting. Confined at present to military use, forecasting of this type has improved greatly as knowledge of the effect of the many oceanographic and meteorological variables has increased. High-accuracy electronic navigation systems, of both governmental and commercial design are being employed with increasing success to control new hydrographic surveys.

### AERONAUTICAL CHARTS

During recent years the United States has made significant progress in the field of aeronautical charting. The great expansion in aviation activities throughout

the world and the rapid developments in increased speed and range of aircraft have placed a heavy burden on those who are responsible for production and design of aeronautical charts and related publications. The most significant progress of late has been the improvement of the quality of existing materials. Such improvements are represented by increased cartographic accuracy, better portrayal of information, and incorporation into graphics of more complete and accurate source information.

Maintenance continues on the following standard series charts, most of which afford world coverage:

- World Aeronautical Chart, scale 1:1,000,000
- Pilotage Chart, scale 1:500,000
- Aeronautical planning charts, scale 1:5,000,000
- Pilot's handbooks (conventional)
- Pilot's handbooks (jet)
- Radio facility charts
- Supplementary flight information documents
- Jet flight information manuals

In order to develop a universal aeronautical chart series that would fulfil requirements of high-speed, long-range, and high-altitude aircraft for radar, celestial, dead reckoning, and visual navigation, extensive research was conducted by the United States during the past two years. This has resulted in the development of the Jet Navigation Chart Series.

This series is being produced at a sheet size approximately 42 inches by 58.5 inches, on a Lambert conformal conic projection (except in polar areas) and is designed to include topographic features, names, aeronautical information, and other information required for navigation of jet aircraft. These charts are so designed that strips of twelve inches or more in width may be cut from them and used independently where operational space is limited. Preparation of complete world coverage is under way.

A number of changes have been made or are being made for the improvement of the V-30 aeronautical charts. This programme is designed to meet the specialized needs of high-performance aircraft flying extreme distances at high speed, and to fulfil requirements of visual pilotage as well as standard and radar navigation. The Mercator projection has been retained for both land and water areas. The charts show generalized contours and display elevation tints in subdued colours. Information on coastal water depths has been included.

To fulfil certain military requirements some aeronautical charts are being plasticized. This provides for continuing use of charts which require frequent annotations or markings since markings made can be easily wiped off.

#### GRAVIMETRY

The United States is engaged in an extensive world-wide gravity programme. Gravity data are being accumulated from all official and commercial sources possible, and, as much as possible, being reduced to a common datum. In this respect, as many national gravity base stations as can be occupied are being tied

together by means of standardized quartz pendulums, thus effectively establishing a basic instrument from which to compute all world-wide gravity values.

With this same set of instruments, many gravity bases are being established over the earth, from which more extensive surveys are being conducted by gravimeters, thus supplying very extensive gravity data. After this work has been accomplished, much more accurate figures for the undulation of the geoid can be determined, deviation from the vertical can be more assuredly established at any given place, thus geodesy can be further refined beyond its present accuracy.

In areas where no specific gravity information is available, the United States is sponsoring commercial contracts for determining the isostatic anomalies, in so far as possible, by computing average elevations and densities 5' x 5' areas (5' x 10' in the northern latitudes), and extrapolating from known gravity stations to obtain deviation from the vertical and undulation of the geoid over inaccessible areas.

Newly developed procedures have been adopted to minimize temperature, magnetic, and flexure effects in observations with the Brown pendulum apparatus. A system of eleven gravity base stations was established in Alaska in 1952 using air transport. The gravity range in this territory was covered by five pendulum stations, and six additional stations were observed with a Worden gravity meter. Six key stations were re-observed by pendulum on calibration line extending from Brownsville, Texas to Winnipeg, Manitoba.

#### GEODESY

In 1952 the United States sponsored studies of solar eclipses for geodetic purposes. An expedition in Africa for this purpose in 1952 was undertaken, and in view of the fact that the use of solar eclipse data for geodetic information seemed feasible, another extensive expedition was organized to study the 1954 solar eclipse under contracts with Ohio State and Georgetown universities. Three systems were used to study this solar phenomena: the minimum light or photoelectric method, utilizing the light intensity variation during the eclipse; the Bonsdorf method whereby the solar crescent is photographed before and after the total eclipse; and the Lindblad method in which a study is made of the flash spectrum just prior to and following second and third contacts, respectively. Preliminary results indicate that the use of solar eclipse data for geodetic purposes is highly satisfactory. When final results have been obtained, it is thought that the present probable error in long-range distance and intercontinental ties will be reduced by approximately 50 per cent. It is felt that, with this method, a geodetic tie can be made between all major geodetic data within about a twenty-year period.

A long-range occultation programme in the Pacific is being planned to start in 1954. This programme will include geodetic connexions between various islands and island groups, with an ultimate connexion



to the Asian mainland and Tokyo datum. It should greatly improve a serious navigational problem in the Pacific arising from the present inaccurate positioning of the Loran stations. It will likewise provide accurate positions of the islands with respect to each other and to the mainland.

The United States has been engaged in a gravity programme that has been accumulating as much as possible of a world coverage of gravity observations for geodetic purposes. The broad objectives are to determine gravimetrically:

- (1) The flattening  $\alpha$  of the reference ellipsoid;
- (2) The undulations  $N$  of the geoid;
- (3) The deflection of vertical components  $\zeta$  and  $\eta$  at any point in the world;
- (4) A world geodetic system by converting the existing geodetic systems to the same system;
- (5) A reduction for the triangulation base-lines from the geoid to the reference ellipsoid;
- (6) A correction for triangulation stations in mountainous regions due to the effect of the deflection of the vertical.

Combining the gravimetric method with astronomical observations will produce:

- (1) Control for maps at scale of 1:100,000 and at smaller scales in areas where adequate triangulation is not available. The error of the control points, computed from gravimetric-astronomic data, is of the order of thirty to forty-five metres, which is not larger than the drafting and reproducing errors of maps at 1:100,000.
- (2) Distances between any points *along the reference ellipsoid* with an accuracy of about fifty metres, regardless of whether they are 50 kilometres or 10,000 kilometres apart.
- (3) Geoidal distances from ellipsoidal distances.
- (4) Super geodetic control points which will control the accuracy of long range triangulation.

From the existing triangulation the correct dimensions for the reference ellipsoid can be determined. For this it is only necessary to compare the differences ( $\zeta g - \zeta a$ ) and ( $\eta g - \eta a$ ) between the gravimetrically and astro-geodetically computed deflections of the vertical components  $\zeta g$ ,  $\zeta a$  and  $\eta g$ ,  $\eta a$  at astronomical points close to both ends of the triangulation chains. If these differences are not large, the chosen ellipsoid is satisfactory. If they differ systematically with the distances from the initial point, it is necessary to correct the ellipsoid until these systematic differences disappear.

The accomplishments of the programme to date include:

- (1) Study of the various methods used in reducing gravity anomalies and adoption of the isostatic Airy reduction with thirty kilometres as the thickness of the earth's crust. However, for preliminary computations of the undulations of the geoid and deflection of the vertical the free air reduction with condensation corrections is being used.

- (2) Accumulation of a vast number of gravity observation from geodetic and other interested in-

stitutions, as well as oil companies and individual scientists.

- (3) Preparation of a card catalogue of the principal facts of all available gravity observations by one degree squares.

- (4) Preparation of a card catalogue of approximately 1,000 gravity base stations.

- (5) Preparation of mean gravity anomaly maps based upon average anomalies for  $10' \times 10'$  square.

- (6) Studies on the feasibility of adapting isostatic reductions for high-speed computing machines.

- (7) Preliminary gravimetric computation of the deflections of the vertical.

## Cartographic Techniques

### PRODUCTION OF COMPILATION MANUSCRIPTS

A method of employing a modified pull-up technique for the production of compilation manuscripts is now being used. Original pull-ups are prepared as colour-separated copies on plastics which are subsequently photographically reduced to scale. The resulting negatives are panelled to a format and contacted to vinyl bases to create "separation positives". Each positive is processed by successive multiple exposure to a dyed stable plastic to produce a multi-coloured compilation manuscript. As opposed to the final inking step required under previous methods, a considerable time saving and a clearer manuscript are realized.

### SHADED RELIEF FROM PLASTER MODELS

Continuing developments are aimed at the achievement of a practical method for obtaining shaded relief negatives by photographing plaster relief models. For this purpose a "bench camera" was erected. The direction of collimated light reflected from the copy onto the focal plane of the bench camera makes possible true and accurate rendition of elevations. As opposed to air brush relief drawings, this photomechanical product minimizes human error, eliminates misinterpretation by air brush artists, and results in more uniform portrayal of terrain.

### HIGH-ALTITUDE PHOTOGRAPHY

High-altitude photography, scale about 1:60,000, is now being used successfully in precise stereo-plotting instruments for compilation of some geologic maps in western United States.

### GRIDDING

A procedure has been worked out for orthographically transferring small-mesh grids from aerial photographs to map or manuscript bases to provide for later transfer of geologic or other detail from photographs to such bases in lieu of plotting instruments of any type.

### PHOTOMECHANICAL PRODUCTION OF SPHERICAL MAPS

Continuing developments are aimed at the production of multi-coloured global maps with a high degree of

racy. It is expected that the objective result will eliminate most inaccuracies inherent on existing aerial maps.

#### NEGATIVE SCRIBING

Considerable progress has been made in the past years towards the development of negative engraving (scribing) as a cartographic media substitute for drafting in colour separation work. This process engraving on specially coated plastic materials has proved more satisfactory than drafting. It saves considerable training and operation time, without loss of quality, and, since scribed sheets are in negative form, eliminates the "positive to negative" step required prior to reproduction. Great advancement has also been realized in the quality of coating emulsions, and several commercial sources of pre-coated sheets are now available. The instrument design and development have generally kept pace, and commercial sources of supply for all basic instrumental requirements are now available.

Most of the development work associated with negative scribing has occurred through its adaptation by the Federal Government mapping and charting agencies. Practically all of these agencies have converted or are converting their map and chart finishing operations from drafting to negative scribing. Some Federal Government mapping agencies are integrating procedures applicable to the topographic mapping programme as a whole. This involves the application of scribing techniques to direct stereomapping delineations and to field intermediary manuscript inspection and revision operations.

#### SYMBOL STANDARDIZATION

The various charting agencies of the United States Government have formed committees whose objective is the achievement of uniform and standard cartographic symbolization on map products. This effort is specifically aimed at the determination of common symbolization for naval, air and ground maps and charts.

#### USE OF AUTOGRAPH AND STEREOPLANIGRAPH

The Wild A7 Autograph and the Ziery C8 Stereoplanigraph have been introduced in aeronautical charting operations to complement other stereoplotting instruments such as the Kelsh plotter, Multiplex, and Mahan Wernstedt plotter. The high-precision instruments are used in special stereophotogrammetric operations such as stereotriangulation and accurate position determination.

#### Cartographic Equipment

##### ER-55 PROJECTOR

The ER-55 projector was designed for use on either the Twinplex plotter with convergent low oblique photography or the conventional Multiplex frame. Testing of this equipment indicates that it will fulfil anticipated high performance standards.

#### VARIABLE-RATIO PANTOGRAPH

A precision variable-ratio pantograph was developed for attachment to either the Kelsh or Multiplex instrument to permit compilation at or close to the publication scale rather than at model scale. The reduction that can be obtained with the new pantograph is continuously variable from 1.5 to 6.5 times.

#### ALIDADE IMPROVEMENTS

Some of the most recent innovations in instrument design have been adopted for use in modernizing the standard telescopic alidade. The exposed, brass vertical-arc and its levelling bubble on the standard model were replaced by an enclosed, optical-reading glass circle which is automatically levelled by a pendulum device. The old clamp and tangent screw were replaced by an enclosed worm-gear assembly, packed in grease, and attached to the telescope with a friction clutch requiring no clamp.

#### STEREOTEMPLETS

Triangulation utilizing stereotemplets is a recently developed method of achieving the horizontal scale solutions required in photogrammetric mapping procedures. A stereotemplet is a composite slotted templet that is a mechanical representation of the horizontal plot of a stereoscopic model. It is specifically designed for use in conjunction with stereoscopic plotting equipment and to exploit the advantages of the stereoplotting technique. The stereotemplet method incorporates the precision and geometric strength of the stereoplotting technique with a templet system that contributes the favourable qualities of an area solution. This method may be of special value in areas where the amount and distribution of existing horizontal control are not suitable for effective stereotriangulation by individual flight strips.

#### KAIL RADIAL PLANIMETRIC PLOTTER

The Kail radial planimetric plotter is a simple stereoscopic plotting instrument using radially intersecting arms to determine orthographic positions of geologic features seen on aerial photographs.

#### MULTIPLEX AND KELSH PLOTTERS

These precise projector-type stereoplotting instruments, long used in topographic mapping, are now being used in interpretation and orthographic plotting of geologic features from aerial photographs.

#### OBLIQUE HEIGHT FINDER

An oblique height finder has recently been developed as a companion instrument to the photoalidade. This instrument was designed for use in determining ground elevations in those portions of the oblique photographs nearest the flight line which cannot be determined by the photoalidade. The instrument measures parallax of common points in such a manner that the parallax can be translated into differences in elevation.

### MODIFICATION OF STEREOSCOPIC PLOTTER

A modification was effected on the stereoscopic plotter (Kelsh type) to provide a stereoplotting capability for trimetrogon oblique photography. The modification involved major changes in the frame and a few minor changes in the projectors. The instrument can be easily converted for use with vertical or convergent photography.

### SUPER-DUPER DIPPER

The Super-duper Dipper is a recently developed instrument for determining apparent slopes in stereoscopic models of vertical aerial photographs.

### FILM VIEWERS

Two models of a film viewer, designed for inspecting and indexing, have been developed and are now in use. These devices were designed specifically to be used with aerial cartographic photography (9"×9" and 9"×18") and differ from other models primarily in the separation of the light source from the film by two glass plates separated by a sealed air space. Six-watt, daylight, fluorescent tubes are used as the light source in both models. For use during indexing, the 9"×9" model is equipped with a desk stand that places the viewer at a convenient angle for the operator and permits easy rotation of the viewer through 360 degrees for orientation with a map.

A 9"×9" film viewer of the type described above has been combined with a commercial model densitometer for use as an inspection device for aerial cartographic photography. The densitometer and viewer are mounted together on a base and the film to be inspected is fed through a series of rollers, first across the film viewer and then through the densitometer and back to the take-up spool the film viewer. Since the device is used primarily in the field, its base is also the base of a sturdy oak chest, the top and sides of which are easily removed when the unit is in operation.

In order to determine differential shrinkage in aerial photographic film, a direct-reading scale has been designed. An eleven-inch length of invar steel has been fashioned to permit two clear plastic inserts to be permanently affixed within the bar. One insert has a cross-line reticule etched on one surface, and the second insert is graduated in 0.1 millimetres for a 1.5 centimetre length. The inserts are positioned in the bar approximately 225 millimetres apart on centres. The inserts are flush with the bottom side to eliminate parallax, and each insert is viewed from the top through a magnifying device that can be folded down when the instrument is put in its case. The distance between the cross-line reticule and the middle line of the graduated scale is accurately determined and is used as the origin for film measurements.

### CHARTING PHOTOALIDADE

A new-type charting photoalidade was developed, based on the Wilson photoalidade, to afford more accurate and efficient determination of ground eleva-

tions from oblique photography. The instrument will be usable with a greater variety of photo sizes, focal lengths, and camera angles. The equipment can accommodate focal lengths of 6 to 12 inches, picture sizes 9"×9" and 9"×18", oriented in either direction, with depression angles of 0 to 90 degrees. A Wild T-1 theodolite is used for the theodolite, which is connected to a straight edge for ruling on a manuscript. The print is held on a vacuum plate. Provisions are made to adjust the instrument and make rapid changes in the set-up when using various types of photography.

### VARIABLE PERSPECTIVE CAMERA

This camera consists of a telecentric system composed of a spherical mirror thirty inches in diameter (focal length 180 inches), a camera with a forty-eight-inch focal length process lens, and a tilting easel. This arrangement permits the accomplishment of an affine transformation of an image by holding one dimension fixed and reducing the other as desired. With this equipment any type of projection can be transformed into any other type of projection by photo-mechanical processes. Any large chart maintenance or compilation programme can be accomplished with fewer highly skilled personnel in the compilation units.

### AERIAL MAPPING CAMERAS

#### Type T-11

The T-11 Aerial Mapping Camera is designed to obtain aerial mapping photography for use in the compilation of maps and charts. It is equipped with the 6-inch f/6.3 metrogon lens that has less than 200 microns radial distortion. Calibration curves for each camera are available. Negative number, barometric altitude, mission data card, camera serial number, fiducial marks and time of exposure are recorded on each negative. Format size is 9"×9" and film capacity is 390 feet of 9½-inch film. F/8.0 and F/11 Waterhouse stops are available for installation on the Rapidyne shutter. The camera operates from standard intervalometers and weighs 89 pounds loaded with 390 feet of film.

#### Type KC-1

The KC-1 Aerial Mapping Camera is designed to obtain aerial mapping photography from which photogrammetric measurements can be taken and utilized in the compilation of maps and charts. It is equipped with the six-inch f/6.3 planigon lens that has less than 20 micron radial distortion. Calibration curves are available for all cameras. Negative number, barometric altitude, mission date, calibrated focal length, lens serial number, fiducial marks, film shrinkage markers and time of exposure are recorded on each exposure. Format size is 9"×9" and the film capacity is 390 feet of 9½-inch film. F/8.0 and f/11 Waterhouse stops are available for installation on the Rapidyne shutter.

### AIRCRAFT CAMERA MOUNT, TYPE A-28

The A-28 aircraft camera mount is designed to eliminate effect of aircraft roll when taking vertical

erial photographs. It has a  $\pm 8$  degree freedom in roll and pitch axis and stabilizes to  $\pm 30$  minutes of arc of the vertical. The mount can be rotated by remote control in  $\pm 40$  degrees of azimuth. The mount weighs 120 pounds and is operated on 115-volt, 60 CPS power.

#### MODIFIED SALTZMAN RP-6 RECTIFIER

In order to fulfil a requirement for an instrument to accomplish photo rectification of trimetrogon oblique photography on a production basis one Saltzman RP-6 rectifier was modified. Changes to afford greater tilt involved alterations to the easel, change in the position and location of the negative carrier, and movement of the lens closer to the negative carrier. While reasonably accurate rectification can be accomplished with the modified instrument, the resolution of the rectified prints is not as good as with other rectifiers.

#### MODIFIED POLAROID LAND CAMERA

A technique using a modified Polaroid Land camera has been developed to permit accurate spacing of flight lines over uncharted areas. The camera is mounted in the aircraft in such a manner as to take selected photos of check points on the flight line or the adjacent flight line. The prints are developed within the camera in less than sixty seconds. They are used by the photo navigator as a visual aid in the navigation of the adjoining flight line. The installation weighs less than four pounds and requires no power.

#### Reproduction Technique

##### VIGNETTING OF OPEN WATER AREAS

A photomechanical technique has been developed for vignetting open water areas on maps and charts using a reproduction negative of the line drawing of the drainage plate only. Through this technique it is possible to show deep blue for water nearest the shore with a gradual reduction of the intensity of the blue tint away from shore until only white appears a considerable distance from shore.

#### STEP PROCESSING PHOTO COPY TECHNIQUE

A step processing photo copy technique has been developed. Inferior photographic copy was formerly reproduced by photomechanical methods for distribution in order to preserve the maximum in definition. A method of progressive three-step photo copying of originals has been devised which improves definition to the extent that it can be reproduced successfully by lithography.

#### PAINTING ON PLASTIC

Considerable development has taken place in connexion with printing on plastic media. Through the use of celluloid inks and anti-static compound ink driers, and modification of the press, printing on

plastic media by normal offset lithographic methods is now possible.

#### LAC-STRIP METHOD

A method is under development whereby reproduction negatives of contour line drawings are exposed on pre-coated lacquer stripping film in the preparation of gradient tint "open window" negatives. A solvent etch is utilized to clear desired contour lines. Remaining opaque coating between lines is then stripped off by hand. It is expected that this method will reduce the art room time for preparing gradient tint negatives to approximately 5 per cent of the time required by conventional methods.

#### PHOTOMECHANICAL FILM REVERSALS

In developing photomechanical film reversals, procedures have been devised to permit the direct reproduction of positive copy from positive originals and negative copy from negative originals.

#### OPEN FACED VACUUM FRAME

A new open faced vacuum frame which has a pliable transparent cover has been substituted for glass, which improves contact. This, in turn, improves the definition of fine detail. The open faced frame is used in combination with a contact screen for the production of tints over large areas. This eliminates the necessity of preparation by camera and improves the quality of the finished product.

#### GRAINLESS PLATES

The production and utilization of plates which are not mechanically grained has proved satisfactory in reproduction runs. Variations encountered made advisable continuing development to establish standards for full-scale production. The grainless plates have unlimited re-usage, print a sharper image, and provide a substantial economy by rendering graining operations unnecessary.

#### INK DISTRIBUTION SYSTEM FOR PRINTING ON PLASTIC

The ink distribution system of the press used for vinyl printing has been modified to reduce the ink travel distance. The reduction of the long travel distance, normally a requisite for ordinary lithographic printing, was necessary for satisfactory inking with plastic inks. It is conceivable that the development achieved will influence future press design.

#### PRODUCTION OF ETCHED PLATES

A photolithographic process has been developed for producing etched lines on metal plates in conjunction with the preparation of the step-laminate for relief model making. Heretofore, such plates were produced commercially by photoengraving. The new process makes practicable the production of relief models by military field units.

## Miscellaneous Mapping and Charting Equipment

### OCEANOGRAPHIC INSTRUMENTS

A considerable amount of developmental work has been expended in an effort to improve oceanographic instrumentation. Instruments that have been developed include: the accelerometer wave staff, submarine photometer, magnetic wave analyzer, microthermal recorder, ship-borne atmospheric temperature lapse rate indicator, and ship-borne pyreheliometer array. In addition, programmes have been conducted to improve the speed and accuracy with which data are recorded and analysed, utilizing such devices as electronic counting mechanisms and magnetic tape recorders.

### ELECTRONIC POSITION INDICATOR

Use of the electronic position indicator system for the control of hydrography has continued. Some basic changes have been made in the equipment to improve its reliability and with a view to making the ground stations function more nearly automatically. Accuracy and range remain about as in the original equipment. However, no long runs have been made to determine maximum range.

### PORTABLE DEPTH RECORDER

An improved small portable depth recorder is under development and should be available for use in a short time. One field test (two weeks) showed that the instrument is well designed and that it should meet the requirements of a surveying instrument.

### CURRENT METER RECORDER

To help reduce the cost of observing currents and thus make it possible to obtain more observations, a current meter recorder has been developed that eliminates the need for constant attention by an operator. When attached to a radio current meter this instrument automatically records the velocity and direction of the current continuously for seven to nine days before record tape and batteries require renewal. One of the principal features is that separate pens record time, direction and velocity. It is operated by batteries and may be used in a buoy or directly on board an anchored ship where a meter is lowered over the side. When used in a buoy, a radio can be used to monitor its operation. With the proper radio hook-up it can also record on board ship the current signals transmitted from a radio current buoy. This instrument is to receive its first extensive field tests during the year 1955.

## ECHO SOUNDERS

As a result of efforts of various government agencies, private concerns are now producing a portable echo sounder of very satisfactory accuracy and dependability for coastal surveys. For deep water hydrography, efforts are directed towards improved use of existing high-power echo sounders by means of accurate frequency control and scale expansion of recording devices.

### ELECTRICAL ANALOGUE COMPUTER

A new electrical analogue computer to permit rapid analyses of strong motion seismograph records has been developed.

## Mapping and Charting Studies

### SEISMOLOGICAL STUDIES

A new correlation between ocean swells and micro-seisms as recorded on an ocean island has been developed and checked. Several investigators are now using models and ultra-high-frequency waves to study the propagation of seismic waves.

### EFFICIENCY OF PHOTOGRAMMETRIC SYSTEMS

The United States has completed a statistical study of C-factors<sup>1</sup> that can be expected from given photogrammetric systems under various conditions. The study is based on accuracy checks of a large number of recently completed maps. The results obtained indicate that there is no constant C-factor value for a given photogrammetric system. Rather, the results are expressed in the form of probability curves.

### SYSTEMATIC ERRORS IN AEROPHOTOGRAMMETRIC SURVEYS

A study has been made in the United States on systematic errors in aerophotogrammetry. Conclusions are that in aerophotogrammetric surveys there are three general classifications of systematic errors: external errors, instrument errors and personal errors. Sources of systematic errors can be detected by a careful study of every phase of the aerophotogrammetric system. Furthermore, most of these errors can be evaluated in advance, and steps can be taken to reduce or eliminate their effects.

<sup>1</sup> Defined as the flying height over the contour interval.

## MEANS OF OBTAINING REGULAR SMALL-SCALE PHOTOGRAPHIC COVERAGE

by

*Institut géographique national, Paris, France*

The original text of this paper appeared in French as document E/CONF.18/A/L.16, under the title "Moyens à mettre en œuvre pour réaliser une couverture photographique régulière à petite échelle dans les régions dont il n'a pu encore être dressé qu'une cartographie insuffisante").

In all territories where cartographic facilities are adequate, the main effort should be directed towards obtaining a complete aerial photographic coverage in the form of small-scale vertical photographs. Once complete coverage has been obtained, it is possible: (a) to make use of the photographs immediately to meet the needs of many users (through such means as stereoscopic interpretation of original photographs and photoplans) without having to draw the map; (b) to process the photographs by simple methods with a view to publishing small-scale maps (for example, 1:200,000) as soon as possible; (c) to use the photographs to prepare medium-scale and large-scale maps employing the most up-to-date techniques and reducing old work to an absolute minimum.

The value of photographic coverage of this kind in the newer countries cannot be overestimated. It is attested to by the insatiable demand for such maps and photographs on the part of the main technical services in areas where air surveys of this type have been made.

However, the coverage is not of great value unless the following requirements are met:

(1) The photographs must be vertical, with not more than one or two degrees of tilt;

(2) They should be stereoscopic (so that the configuration of the ground can be judged and the detail can be interpreted);

(3) The scale must be small (to permit rapid processing);

(4) The photographs should have high definition (capable of enlarging at least five times);

(5) The standard of navigation of the photographic aircraft needs to be high (straight parallel strips with narrow lateral overlap);

(6) Each flight should cover a fairly large regular quadrilateral, bounded by meridians and parallels (not less than 80 to 100 kilometres);

(7) The photographs must be taken with high-precision, wide-angle mapping cameras, preferably using plates, so that the negatives can more readily be used for the aerial triangulation which is an essential part in the map-making process.

If the coverage is to meet these requirements, it is necessary to have selected crews, specially trained to carry out exacting photographic missions, and powerful, reliable aircraft capable of operating for long periods at high altitudes (7,000 to 9,000 metres) and with first-class navigational facilities. When very large areas are to be covered, it is necessary to have well-organized photographic units capable of making full use of periods of weather favourable for photography. A typical unit would consist of four photographic aircraft with the following characteristics:

(1) Metal construction, permitting operation in any latitude;

(2) Four engines, for safety during long flights over inhospitable terrain far from air bases, and to give the aircraft the necessary flight characteristics;

(3) High ceiling—about 10,000 metres—permitting normal operating altitudes of over 8,000 metres;

(4) Operating speed close to 400 kilometres per hour;

(5) Good endurance, giving at least eight hours of operation at 8,000 metres, and long range, permitting movement from one area to another at short notice to make full use of periods suitable for photography, which are very infrequent in some regions;

(6) Forward observation compartment with good visibility<sup>1</sup> for navigational purposes;

(7) Roomy fuselage to permit easy handling of the cameras and magazines.

Ten mapping cameras (preferably plate cameras) should be carried, with enough magazines to provide 800 plates per aircraft.

At least four crews should be available, each consisting of one pilot, one navigator, one flight engineer, one radio operator and one photographer. The ground staff should consist of three aircraft mechanics, three fitters, one instrument repairer, one electrician and

<sup>1</sup> Highly trained crews like those of the National Geographical Institute are able to use visual navigation methods (drift sights) to carry out perfectly navigated photographic flights even over unmapped and desert areas, or over tropical forest, without radar or other aids.

two photographers.<sup>2</sup> In all, this would comprise twenty flying and ten non-flying personnel. The amount of work that a unit of this kind can do depends on weather conditions in the territory to be photographed and the distance of the areas to be photographed from the base airfields, which must have a 1,600-metre runway and be capable of carrying a weight of thirty tons.

Maximum efficiency is achieved for areas not more than 400 kilometres from the base, since the flying time required to reach the area is approximately that required for the aircraft to reach an altitude suitable for taking photographs at a scale of 1:50,000 or 1:60,000. When the areas to be covered are 800 kilometres away from the airfield, efficiency falls by about 30 per cent, apart from the additional hazards due to possible weather changes between the time of take-off and of arrival over the area to be photographed.<sup>3</sup> For practical purposes, 900 kilometres is the maximum distance at which large areas can be photographed.

The National Geographical Institute, which has had considerable experience in aerial photography, has organized its photographic flights on the lines recommended above. To give an idea of the capabilities of units of this kind, it may be mentioned that two aircraft operating in Indochina, where weather conditions are rather poor, covered 750,000 square kilometres at a scale of 1:40,000 in two seasons of five months each. During 1954, two units of four four-engine aircraft

<sup>2</sup> This figure should be increased if it is intended to have much photographic work done on the spot (developing and print-making, for example).

<sup>3</sup> Wherever the climate is unfavourable, it is not possible to cover areas more than 400 kilometres away from the base airfield.

operating successively in the areas of Brazzaville (French Equatorial Africa), Dakar (French West Africa), Madagascar, Douala (Cameroons), Fort Archambault (French Equatorial Africa), Abidjan (French West Africa), Gao (French West Africa), Algiers, Tamanrasset and Aoulef (French North Africa and Sahara) covered over 2.2 million square kilometres at a scale of 1:50,000. Some of the areas covered from Douala, Brazzaville and Abidjan were particularly difficult to photograph, as they have only a few days of good weather a year, and some areas in the northern part of French Equatorial Africa were 900 kilometres away from the nearest base airfield.

On the basis of these results, it may be assumed that four four-engine aircraft organized on the lines recommended would be able to cover over 1.2 million square kilometres a year on a scale of 1:50,000 in areas where photographic conditions are good, such as Turkey, Syria, Iraq, Arabia, Iran, the Ganges plain and Australia.

In territories where conditions are very unfavourable, like the Calcutta area and the western coast of Burma and Malaya, it would be necessary, if results were needed fairly quickly, to station large units in the area so that the maximum use could be made of the few days when the weather is suitable. The photographic units would, of course, only be stationed in the area during the season when clear skies can be expected.

In areas where the difficulties are similar to those met with in Indochina, as in Thailand, for example, it would probably be necessary to provide a large unit (four aircraft) and to have the unit standing by in the area only during the five or six months of the year when conditions are most favourable for photography.



# DESIRABILITY OF MEASURING A STANDARD BASE LINE IN INDIA<sup>1</sup>

by

*Dr. B. L. Gulatee*

*Director, Geodetic and Research Branch, Survey of India*

(The original text of this paper, transmitted by the Delegation of India,  
appeared as document E/CONF.18/A/L.17)

India base-line measurements were carried out in three epochs. The first was between 1800 to 1825, during which period ten base lines were measured with steel chains. These were considered to be worthless controlling principal triangulation and were superseded by ten measured between 1830 and 1869 with the help of Colby compensation bars. These compensation bars were calibrated in terms of Standard Bar A, which was brought to India in 1839. The work of the geodetic triangulation of India was also done during this period, and the length of its sides in terms of the Indian foot, as defined by this standard. From 1930 to date, nine further base lines have been measured with the help of invar wires standardized against modern metric standards.

Steel Bar A does not fulfil the modern requirements of a national standard of length and was not made use of in connexion with the modern base lines, although the triangulation of India is still in terms of Indian feet as defined by this obsolete standard.

The length of Bar A in terms of the international metre is open to doubt. It was compared against the European standard in 1865, and so its length can be

expressed in terms of the imperial yard of that date. In 1894, the yard was compared against the international metre and using this ratio, the following relations are obtained.

$$\text{One Indian foot} = \begin{cases} 0.333\ 331\ 89 \text{ yard (1865 to 1894)} \\ 0.304\ 798\ 41 \text{ international metre} \end{cases}$$

The stability of the British yard between 1865 and 1894 has, however, been suspected, and so this ratio is by no means unimpeachable.

There is, thus, an element of discordance between the older triangulation, based on Indian feet in terms of Standard Bar A, and the new triangulation based on modern metric standards which are converted to Indian feet with the help of the above ratio.

Furthermore, all the base lines in India are of six or seven miles of length, except the one in the extreme south at Cape Comorin, which was measured in 1869/70; it is only 1.68 miles. This was blown up to 7.635 miles by small triangles, which would be considered quite unorthodox these days.

It is thus desirable to have one or two standard base lines in India measured with the help of the Vaisälä comparator to ensure uniform scale in the vast network of India and adjacent countries.

<sup>1</sup> Item 6 (a) (ii) of the agenda.

# USE OF THE INTERNATIONAL MAP OF THE WORLD SERIES IN CHINA

by

*Tang-yueh Sun*

*Director of Higher Education, Ministry of Education*

(The original text of this paper appeared as document E/CONF.18/A/L.18 under the title "Practical Use of the C.I.M. Series in China")

In China, the compilation of the IMW series was planned in 1913, and in the period from that year till 1948 a provisional edition of the map sheets for the whole area of China was produced; most of them should be revised. Though maps of such a small scale are of little value for detailed study of land forms, hydrography, agricultural and industrial possibilities, they have yet given much aid in the work of regional planning and regional economic reconstruction of the country during the past twenty years. For a vast country like China needs maps that show the variety of geographical facts of a large region in a minimized form. The type of map of the IMW series thus suits our practical purposes. Innumerable special maps on scales ranging from 1:500,000 to 1:2,000,000 were made after the scheme of the IMW series, with more or less modification. The most important ones are given below.

## *Hwangho Map from Menzin (孟津) to the Outlet of the River*

Scale: 1:800,000

Compiler: Hwangho Monography Compilation Commission

This map begins at Menzin-hsien in Honan Province to the west, and ends at the river outlet to the east, comprising the old delta region below Chenchow (鄭州) of Honan Province and the new delta region below Lizin (利津) of Shantung Province. On the map are indicated hills, loessic cliffs, dikes along the river sides and the location of dams, rapids, sandbars and other physical features. The portion below Lizin—that is, the new delta region—is mapped more in detail, all the more important changes of river courses, abandoned channels, dikes, breaks in the dikes, etc., being correctly indicated and noted with dates. A map of this character—hydrography map with topographical signs—would render much help for the conservancy work, navigation, highway construction and the land utilization project of the new delta region.

## *Irrigation Maps*

Two maps cover the drainage area of Hwangho valley in Suiyuan Province and Ningshia Province.

Irrigation map of Suiyuan Province:

Scale: 1:1,400,000

Compiler: Suiyuan Provincial Government

Irrigation map of Ningshia Province:

Scale: 1:600,000

Compiler: Reconstruction Department of Ningshia Provincial Government

The major relief such as hills, sand dunes, lakes, marshes and the major land-use items such as canals, arable land, pasture, fallow land and settlements are shown in different colours.

## *Map of the Outlet of the Yangtze River*

Scale: 1:500,000

Compiler: Whangpoo Conservancy Board

This map covers the Yangtze delta region below Nantung-hsien (Kiangsu Province). Land forms, water-ways, sandbars, water depth and shallows, etc., are all shown on the map, especially in the three main water-ways—the North Water-way, the Central Water-way and the South Water-way. A good deal of detailed specification is given for these. Dr. Sun Yat-sen, in his *International Development of China*, emphasized the fact that the future development of Shanghai seaport depends to a considerable extent upon the betterment of these three water-ways. Hence the map so designed would surely give a better comprehension of Dr. Sun's project.

## *Economic Atlas of Kwangtung Province*

Scale: 1:500,000

Compiler: Geography Department of National Sun Yat-sen University

This atlas with twelve sheets was compiled by professors and students of Sun Yat-sen University during the last war, under the sponsorship of the Kwangtung Provincial Government. In addition to these twelve sheets, which cover the whole area of Kwangtung Province, one separate sheet is given to each Hsien (administrative unit) with economic data and necessary explanations. These atlas sets showing the various

conomic features in relation to geography would  
rely render a great service to the public.

*Economic Atlas of South-east Szechwan*

Scale: 1:2,000,000

Compiler: Economic Institute of Szechwan Pro-  
vincial Bank

This atlas with twelve sheets contains a good deal  
the latest information as to the distribution of natural  
sources as well as the modes of their exploitation.

*Soil Map of South Fukien*

Scale: 1:1,000,000

Compiler: Geological Survey of Fukien

Lateritic soils outcrop almost everywhere in the  
uthern part of Fukien Province. Their exact loca-  
ons on the map suggest a rational utilization of these  
mi-arid lands.

*Land-Utilization Map of Hanchun (漢中) Basin*

Scale: 1:500,000

Compiler: Geographical Society of China

In this map, particular attention has been given to  
topographical influence upon soil erosion, which  
already seems alarming in this region.

*Detailed Geological Maps of China*

Scale: 1:1,000,000

Compiler: National Geological Survey of China

These maps are made in accordance with the IMW  
scheme on the same scale, 1:1,000,000. This set of  
maps represents one of the great contributions of  
Chinese geologists to the scientific world.

*Other Maps*

Geological Map of Szechwan Province:

Scale: 1:500,000

Compiler: Geological Survey of Szechwan

Atlas of the Hosi (河西) Region and Sinkiang  
Province:

Scale: 1:500,000

Compiler: Geographical Institute of National  
Central University

# PROGRESS OF CARTOGRAPHIC WORK IN CHINA

by

Dr. Tsao-Mo

Ministry of Interior

(The original text of this paper, submitted by the Delegation of China, appeared in document E/CONF.18/A/L.19, under the title "Communications received from the Chinese Delegation")

The science of cartography was developed early in China. Nearly 1,700 years ago, Pei Hsiu (A.D. 224-273) worked out and established cartographic principles and made a map of the whole of China. Erwin Raisz, author of *General Cartography*, has said, "Cartography was flourishing in China when it was at its lowest ebb in Europe during the Middle Ages". In 1681, China began to adopt astronomical triangulation methods to make a more detailed map of China, which was completed in 1718. The map made then certainly was not accurate enough compared with today's work by means of highly developed scientific methods, but it was a tremendous achievement then, not only in respect of China but in respect of the whole world. The length of each degree of the arc of the meridian, with the variations of the height of latitude, was also discovered during the astronomical triangulation survey for the compilation of the map of China. This was indeed the first discovery by means of practical observation that proved Newton's theory that the earth is an oblate ellipsoid.

China, since 1895, has been planning a project for mapping China on a large scale and for training mapping personnel. In 1910 geodetic and topographic surveys of its provinces were started. Owing to the extent of China's territory, an enormous amount of work was required; 1:50,000 topographic maps of about one-third of the area have been completed. In addition, planning for the map of the world on the millionth scale was started in 1913, and the provisional edition was finished in 1947.

## GEODETIC SURVEYING

China began geodetic surveying in 1910 from the northern part of China, then extended towards the south-west and north-west, working from the east. The instruments and methods used for the surveying have been described elsewhere.<sup>1</sup> The Bessel spheroid was first used for geodetic computation, and in 1930 the Hayford spheroid was introduced. It was the

<sup>1</sup> Dr. Tsao-Mo, "Preliminary Report on Geodetic Work in China since 1900", paper presented to the Fifth Pacific Science Congress, Victoria and Vancouver, B. C., Canada, 1933, and "General Report on the Progress of Surveys in China", paper presented to the Fifth International Congress of Surveyors, London, 1934.

first international spheroid used in Asia. The Hayford spheroid is more suitable for the figure of the earth in the area of China, according to computations of the deflection of the vertical made by the writer.

In 1934, the writer discussed and designed with Dr. Y. Väisälä plans for construction of a comparator for the geodetic survey of China; this was completed the following year. There were more than one hundred Bilby steel towers from 20 to 130 feet high used in triangulation observation at a certain time. Methods of geodetic computation and adjustment used were according to the international specifications.

## Astronomic Determination

The main instruments used in observation were 50 to 70 millimetre Heyde broken-telescope transits provided with impersonal micrometer. The 45-degree astrolabe (geodetic and small type) and 60-degree astrolabe attached to the Wild theodolite were used for second-order observation. The results obtained were as follows:

- (1) 73 first-order stations, with p.e.  $\pm 0.01$  second,  $\pm 0.09$  second,  $\pm 0.18$  second longitude, latitude, and azimuth, respectively.
- (2) 590 second-order stations, with p.e.  $\pm 0.03$  second,  $\pm 0.25$  second,  $\pm 0.2$  second of longitude, latitude and azimuth, respectively.

## Measurement of Base Lines

The 24-metre and 25-metre invar wires were used to measure first-order and second-order base lines; the total number measured was as follows:

- (1) 22 first-order base lines, with average p.e.  $\pm 0.76$  millimetre per kilometre
- (2) 20 second-order base lines, with average p.e.  $\pm 1$  millimetre per kilometre
- (3) 358 third-order base lines

## Triangulation

Wild T3 and T2 theodolites, the Geodetic Tavestock and the Otto Fennel precise theodolite (United States Coast and Geodetic Survey type) were used with the most satisfactory results for observation of first-order and second-order triangulation. The number of points determined in different provinces were as follows:

- 1) First-order stations, 930 points, with p.e.  $\pm 0.6$  second per observed direction.
- 2) Second-order stations, 9,142 points, with p.e. 1.0 second
- 3) Third-order and fourth-order stations, 62,357 points

#### *Precise Levelling*

Among the eight main tide stations set along the coast of China, the Kangmun tide observatory, with continuous automatic recording for over ten years, is a station of level datum with which all the levellings are connected. The elevations above mean sea level for the whole of China are referred to this datum.

The Wild and Watts precise instruments used for levelling gave most satisfactory results. Up to the present the total length of the precise and second-order levelling run is as follows:

- (1) Precise levelling, total length 29,688 kilometres both directions, with p.e.  $\pm 0.01$  millimetre- $\pm 0.05$  millimetre per kilometre
- (2) Second-order levelling, total length 56,252 kilometres in both directions, with p.e.  $\pm 1.7$  millimetres per kilometre

#### TOPOGRAPHIC MAPPING

The topographic map sheets were made on two different scales:

	<i>Sheets completed</i>
Topographic maps on the scale 1:50,000	8,115
Topographic maps on the scale 1:100,000	5,520

#### INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE (IMW)

After the founding of the Central Bureau, International Map of the World on the Millionth Scale, the Chinese Government first planned to make the provisional edition from the 1:100,000 maps. Compilation of IMW sheets was started in 1931. In the first few years thereafter only 20 per cent of the IMW sheets covering the areas of China were published in provisional editions. By 1947, however, provisional editions of all IMW sheets covering China had been published. Most of them should be revised continuously.

Regarding the existing specifications, there are certain points which may need to be modified to suit the conditions of different nations.

#### SUGGESTIONS

As a means of furthering the completion of the international map of the world on the millionth scale, I would, in addition to uniform specifications, suggest that it would be advisable:

- (1) To measure the standard base line with the Väisälä comparator;
- (2) To use the airborne electronic device for mapping and connecting the remote controls between countries and outlying islands.

# THE FIGURE OF THE EARTH FROM MEASUREMENTS IN CHINA

by  
Dr. Tsao-Mo

(The original text of this paper, submitted by the Delegation of China, appeared in document E/CONF.18/A/L.19, under the title "Communications received from the Chinese Delegation")

The first-order astronomic and geodetic operations in the eastern and central parts of China were carried out before 1937 under the writer's direction. These triangulation systems covering the area extended over a range from latitude 28 degrees north to 34 degrees north and from longitude 114 degrees east to 122 degrees east. The Nanking station, which is the

primary International Wireless Longitude station, has been adopted as a provisional geodetic datum for these operations.

In the preliminary investigation of the figure of the earth by the area method from the deflection of the vertical in these systems a number of observation equations have been formed, as shown in table 5:

Table 5. Observation Equations, from Seven Stations

Station	( $\varphi$ )	( $\lambda$ )	( $\alpha$ )	( $\frac{a}{100}$ )	(10,000 $\epsilon^2$ )	"
Latitude						
F .....	- 1.000		- 0.001	+ 0.009	+ 0.049	+ 1.311 = DM
Ch .....	- 1.000		- 0.020	+ 0.104	+ 0.587	+ 4.044 = DM
Sh .....	- 1.000		+ 0.023	- 0.115	- 0.620	+ 2.881 = DM
E .....	- 1.000		+ 0.026	+ 0.089	+ 0.501	+ 2.984 = DM
So .....	- 0.997		+ 0.007	+ 0.090	+ 0.484	+ 3.595 = DM
N .....	- 0.999		+ 0.043	+ 0.192	+ 1.099	+ 4.161 = DM
S .....	- 1.000		- 0.022	+ 0.021	+ 0.115	+ 1.966 = DM
Longitude						
F .....	- 0.001	- 0.849	+ 0.003	+ 0.004	+ 0.004	+ 3.292 = Dp
Ch .....	- 0.012	- 0.864	+ 0.032	+ 0.065	+ 0.059	+ 6.080 = Dp
Sh .....	+ 0.015	- 0.828	- 0.035	- 0.075	- 0.067	- 1.553 = Dp
E .....	+ 0.015	- 0.862	+ 0.027	- 0.083	- 0.075	- 0.716 = Dp
So .....	+ 0.040	- 0.861	+ 0.028	- 0.214	- 0.193	- 3.132 = Dp
N .....	+ 0.024	- 0.877	+ 0.059	- 0.138	- 0.124	- 0.013 = Dp
S .....	- 0.014	- 0.851	+ 0.007	+ 0.072	+ 0.065	- 0.771 = Dp
Azimuth						
F .....	- 0.003		+ 0.604	+ 0.004	+ 0.004	+ 2.527 = Dp
Ch .....	- 0.047		+ 1.684	+ 0.065	+ 0.059	- 11.345 = Dp
Sh .....	+ 0.049		+ 1.511	- 0.075	- 0.067	- 0.350 = Dp
E .....	+ 0.060		+ 1.670	- 0.083	- 0.075	+ 5.940 = Dp
So .....	+ 0.154		+ 1.663	- 0.214	- 0.193	+ 9.320 = Dp
N .....	+ 0.105		+ 1.764	- 0.138	- 0.124	+ 1.510 = Dp
S .....	- 0.050		+ 1.613	+ 0.072	+ 0.065	- 3.320 = Dp

The normal equations thus formed in the usual way from the above observation equations are shown in table 6.

Table 6. Normal Equations

$(\varphi)$	$(\lambda)$	$(\alpha)$	$(\frac{a}{100})$	$(10,000e^2)$	"
-7.040	-0.058	+0.318	-0.468	-2.283	-19.600 = 0
-0.058	-5.131	-0.106	+0.319	+0.285	-4.093 = 0
+0.318	-0.106	-18.975	-0.619	-0.499	+46.467 = 0
-0.468	+0.319	-0.619	-0.251	+0.591	+0.657 = 0
-2.283	+0.285	-0.499	-0.591	-2.579	+7.906 = 0

The values of the unknowns derived from the solution are given as follows:

$$\begin{aligned}(\varphi) &= 2.459 \text{ seconds} & (\alpha) &= 2.66 \text{ seconds} \\(\lambda) &= 1.119 \text{ seconds} & (a) &= -533 \text{ metres} \\(e^2) &= -0.000031\end{aligned}$$

Applying the corrections  $(a)$  and  $(e^2)$  to Hayford 1909 values, and converting the results into the more common form of expression, the following values expressing the figure and size of the earth are obtained:

$$\begin{aligned}\text{Equatorial radius} &\dots\dots 6,377,855 \pm 12 \text{ metres} \\ \text{Reciprocal of flattening} &\dots\dots 297.4 \pm 0.3 \\ \text{Polar semidiameter} &\dots\dots 6,356,479 \text{ metres}\end{aligned}$$

#### CONCLUSIONS

As the topographic deflections with isostatic compensation have not yet been taken into account, both

values of the equatorial radius and the polar semidiameter are shorter than the corresponding values derived from the Hayford spheroid.

Although the dimensions of the earth are derived from the observed deflections of the vertical in a limited area in China, they approach quite closely those of the Hayford spheroid. Hence the Hayford spheroid adopted for the computations of geodetic measurements in China is probably the most satisfactory one.

More determinations of the figure of the earth from geodetic and gravity measurements in other parts of the areas of China should be made, and the topographic deflections with isostatic compensation considered. As a matter of fact, results of measurements in the south-western part of China are now being computed.



## SPECIFICATIONS GOVERNING THE PUBLICATION OF THE INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE

This document<sup>1</sup> contained the resolutions adopted by the Second International Conference for the International Map of the World on the Millionth Scale, held in Paris in December 1913, and also resolutions adopted by the International Commission of the Map of the World on the Millionth Scale at a meeting in London in July 1928. The official text in English and in French of the resolutions of the former can be found in the "Comptes rendus des séances de la deuxième Conférence internationale";<sup>2</sup> pages 108 to 127. The resolutions of the International Commission may be found in the Central Bureau's publication *Carte du monde au millionième, rapport de 1928*<sup>3</sup> pages 43 to 48.

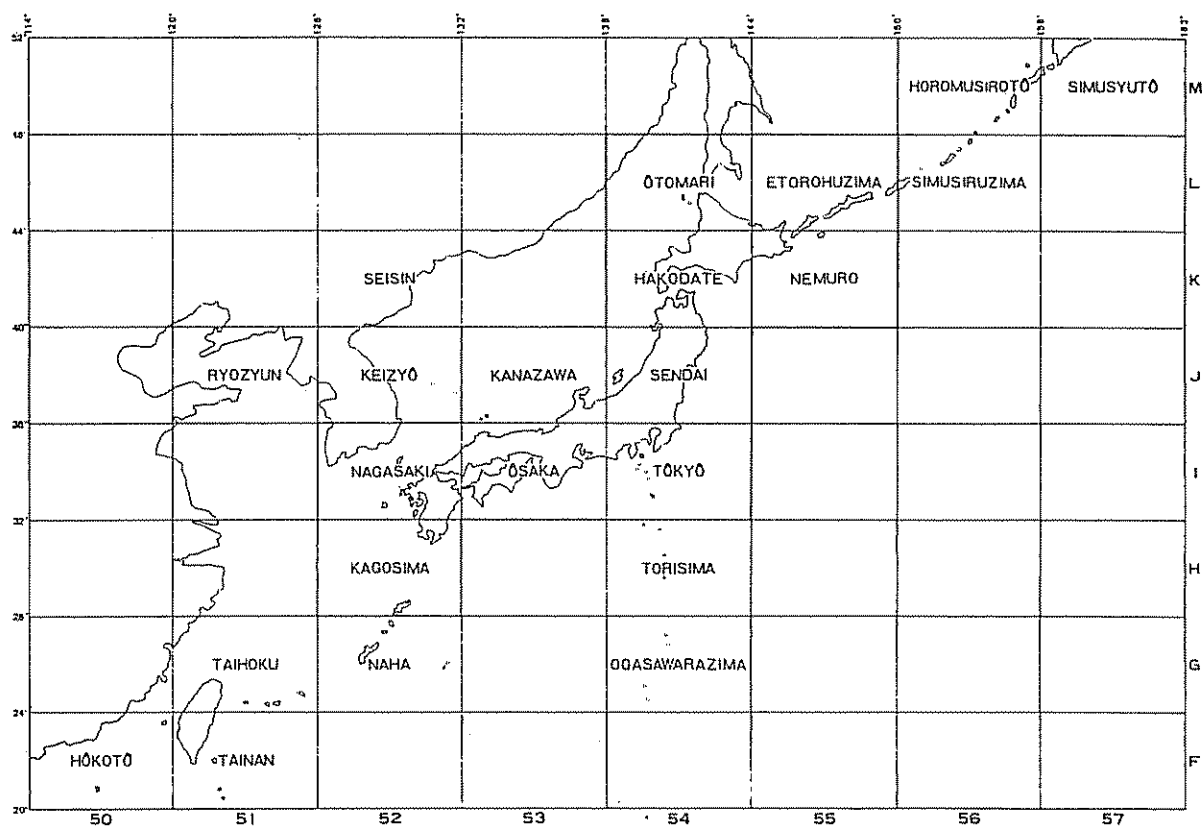
---

<sup>1</sup> The original text was issued as document E/CONF.18/ A/L 20.

<sup>2</sup> Published in Paris, 1914.

<sup>3</sup> London, 1929.

INTERNATIONAL MAP OF THE WORLD ON THE MILLIONTH SCALE:  
MAP SHEET INDEX FOR JAPAN <sup>1</sup>



<sup>1</sup> Issued as E/CONF.18/A/L.21 under the title "Carte internationale du monde au 1.000.000<sup>e</sup>". Submitted by the delegation of Japan.

## FACILITIES FOR STUDYING NEW DEVELOPMENTS

*submitted by the  
Delegation of Burma*

The original text of this paper appeared as document E/CONF.18/A/L.22, under the title "Facilities for the Lesser Developed Countries to Study New Developments in the Neighbouring Developed Countries Whenever Opportunity Arises")

One of the main reasons for inadequate mapping of the world listed by the United Nations Committee of Experts on Cartography is "Lack of exchange of experience and of the interchange of information, *not so much as between the more highly developed countries themselves, but rather as between these and the lesser developed countries*".<sup>1</sup> Here we have a statement to the very point!

Unfortunately, it seems the general rule that the more highly developed countries should be well-informed on one another's techniques and achievements, while the lesser developed countries' lot is to remain practically in a state of stagnation or at best, to lag behind, in this respect. In many cases, they have to content themselves with old, obsolete or uneconomical methods. This is largely responsible for the present unbalanced situation in surveys and mapping.

Another contributory cause of the prevailing situation mentioned by the learned committee is "lack of technical know-how".<sup>2</sup> The provision of facilities for studying new developments in more developed countries will prove a powerful weapon to counteract this lack of technical knowledge.

<sup>1</sup> United Nations, *Modern Cartography: Base Maps for World Needs*, page 9. Italics supplied.

<sup>2</sup> *Ibid.*

It is important to note that the personnel detailed for such tasks of study should not be beginners requiring basic training in the rudiments of surveying, as this involves long academic courses and consequently considerable expenditure. On the contrary, they should be competent persons who have already had complete training and who will be able to comprehend and to apply these new developments after coming in direct contact with them. For instance, they might be permitted to be present at new tests or experiments, such as the recent Canadian experiments on the application of the radar profile to photogrammetric mapping. These visits to other countries would normally be of short duration.

Such constructive assistance would also be conducive to the adoption and practice of uniform international cartographic standards.

An outstanding advantage resulting from this close international co-operation would be the possibility of employing identical methods of surveying in boundary disputes, which would constitute a substantial step in the solution of this complex and controversial problem.

Finally, the sum total of all these benefits cannot but express itself in better understanding and better relations between the various countries of the world.

## RECENT PROGRESS IN BURMA

*submitted by the  
Delegation of Burma*

(The original text of this paper appeared as document E/CONF.18/A/L.23, under the title "Brief Statement on Recent Progress in Burma")

progress of the Burma Survey Department necessarily be reviewed against the war as background, in view of the fact that the country was a front and a twice fought-over battlefield, completely ravaged during this period of devastation.

We have suffered serious setbacks—loss of technical personnel, instruments and equipment, maps, control data, as well as destruction of control stations. The Department has consequently been forced to uphill work, labouring against heavy odds, during acute financial stringency.

Nevertheless, activities so far can be outlined as indicated in the following sections.

### TOPOGRAPHICAL SURVEY

The main problem is revision of existing maps, a large proportion of which have become out of date. Progress in this work is impeded owing chiefly to lack of funds and to the continued employment of the traditional ground methods. Parts of the Shan States have been thus covered. It is anticipated that this survey task will be expedited by application of photogrammetric methods shortly, when more plotting instruments are received and more personnel have been trained in this line.

### CADASTRAL SURVEY

We are faced with the colossal task of replacing the huge volume of cadastral maps that were destroyed or lost during the war, which means in effect a complete survey of the areas concerned. The total area completed so far (including some new surveys) exceeds 1,000 acres.

Here again, it is hoped to increase production by means of photogrammetry as soon as feasible. We are much impressed by the recent experiments in Europe, notably the Beltrum Re-Allotment Survey in the Netherlands, and the test surveys carried out in Austria and Switzerland. These have produced remarkable results, furnishing convincing proof of the value of photogrammetry for cadastral surveys.

### EXTRA-DEPARTMENTAL SURVEYS

This includes miscellaneous surveys for other departments of the Union Government, for state governments,

the armed forces and others. The demands for these, especially large-scale maps for various engineering projects, are increasing rapidly. The urgency of these demands eventually led to the establishment, little more than a year ago, of a separate Aerial Survey Department under the Ministry of National Planning, for the specific purpose of making such project surveys in order to speed up the vast development programmes of the country.

### PHOTOGRAMMETRY

Very recently the above-mentioned Aerial Survey Department was amalgamated with the Survey Department, and has been functioning since as its Photogrammetric Division, its scope of activities being no longer restricted to project surveys, but covering all fields of surveying.

Special mapping has been done for several projects in the country. Maps were plotted for the Saingdin hydroelectric project, for railway construction work and housing schemes, and for irrigation projects, on scales ranging from 1:5,000 to 1:10,000. Full ground control was provided in all cases.

In addition, aerial photomosaics have been compiled of some areas near Rangoon for town and country planning, and of some cantonment areas, proposed industrial areas and the coal-fields in Kalewa. Mosaics have also been prepared for road location in two places. An important item in hand is the compilation of mosaics of the flood valley area of the Irrawaddy River for the Irrawaddy Planning Project.

Air photographs have also been used for interpretation in geology, forestry and soil science, in a number of areas considered to possess potentialities for development of economic resources.

Furthermore, magnetometer surveys, consisting of 8,200 linear miles of magnetic profiles, have been carried out and are presently being compiled into iso-magnetic maps. These maps are considered to be of inestimable aid in geological and mineral resources studies.

A small number of officers who have been specially trained abroad in photogrammetry, assisted by a few foreign technicians, form the nucleus of the organization. The training of technical personnel, which is at present our heaviest responsibility, is receiving

attention, but considerable increase in strength of staff will be necessary to maintain standards of productive capacity.

In conclusion, it is emphasized that the Burma Survey Department is fully alive to the possibilities and importance of photogrammetry. Consequently

it is our aim to adopt photogrammetric techniques (including spatial triangulation) as a regular, standard practice, to the maximum possible extent. But, as already indicated, qualified technical personnel and funds will be the limiting factors in the implementation of our plans.

# ESTABLISHMENT OF AN INTER-GOVERNMENTAL CARTOGRAPHIC ORGANIZATION

*submitted by the  
Delegation of Burma*

original text of this paper appeared as document E/CONF.18/A/L.24, under the title "The Establishment of an Inter-governmental Cartographic Organization to work out Uniform International Cartographic Standards and to give the Necessary Aid to Less Developed Countries, as Done by Other Inter-governmental Organizations, so that the Survey of the World May Be Expedited")

is indeed a sad situation that, notwithstanding (a) increasingly wide recognition of the universal need maps, and (b) the great advance in knowledge in ous fields of cartography, vast areas of the earth remain unsurveyed or inadequately surveyed. ould be superfluous to dwell at length on the need expediting the survey of the world, as we are all edited representatives of various cartographic itutions or else have some connexion with such itutions, and hence appreciate this point only too l. Suffice it to say that maps are vitally essential almost every aspect of modern living; and the elopment of the economic resources of the world rapidly becoming more and more dependent on urate maps.

n various spheres such as agriculture and food duction, health and education, we have found qualities in the world, necessitating the creation of ergovernmental organizations to assist, and to meet specific needs of the deficient or less developed couns, as these have been termed. The outcome of this ation has been the emergence of such international nizations as the International Labour Organisation, od and Agriculture Organization, United Nations ucational, Scientific and Cultural Organization, orld Health Organization and Internal Civil Aviation ganization, all of which have as their ultimate aim : raising of the living standards of the peoples. rtography is no exception; in this respect we find ne countries less advanced than others. It is a llknown fact in cartographic circles that there are ll countries in the world where no primary system geodetically fixed control points exists. We therefore : a very strong need for an inter-governmental carto- aphic organization, even as there is for the other ternational organizations mentioned above, which ould provide necessary assistance and facilities to able such less developed countries to carry out and aintain cartographic activities on as high a level as issible.

One of the root causes responsible for the paucity mapping mentioned by the United Nations Committee

of Experts on Cartography in their report,<sup>1</sup> dated April 1949, is the absence of an international cartographic organization. We quote from page 9 of the report:

"Lack of a qualified international organization, to which recourse could be had for advice and assistance".

This directly envisages the creation of an inter-governmental cartographic organization.

Another of the reasons given by the Committee for "this astonishing situation" in the world is:

"Lack of technical know-how, of equipment, and of the personnel necessary".<sup>2</sup>

What better answer could there be to this than the setting up of an international organization?

The Committee of Experts goes on to give yet another reason for the prevailing unsatisfactory situation and that is the "lack of appreciation by national governments of the fundamental need for maps and of the wide nature of the public services rendered by them".<sup>2</sup> This unfortunate want of appreciation, which so heavily obstructs progress in surveying and consequently in the implementation of all developmental projects, can best be remedied by establishment of an international organization. The existence of such an organization in itself will go far towards enlightenment; its effect would be analogous to that of the World Health Organization in the field of health.

Still another reason put forward by the Committee is "lack of budgetary ability to provide funds for mapping, the benefits of which are mostly long-term, cumulative and indirect, rather than immediate and direct".<sup>2</sup> In such cases, an international organization will prove to be a boon, similar to the International Labour Organization, Food and Agriculture Organization, World Health Organisation and International Civil Aviation Organization.

<sup>1</sup> United Nations, *Modern Cartography: Base Maps for World Needs*, page 9.

<sup>2</sup> *Idem*.

Furthermore, such an organization would be the most effective medium to establish uniform international cartographic standards applicable to mapping throughout the world, and bring to the whole world an international mapping language, where scales, projections, symbols, nomenclature and precision standards would be identical in all countries. The International Civil Aviation Organization has already done this for aeronautical charts, but, strangely enough, the maps on which these charts are based vary widely in scale, in standards of accuracy, and in fact in almost every item of cartographic practice.

The International Map of the World on the Millionth Scale (IMW) was the first step in international cartography, and after some forty years the world is by no means completely covered with these maps, which in themselves are of varying standards and widely different characteristics.

It may be pointed out that the Pan American Institute of Geography and History through one of its committees is endeavouring to arrive at a certain measure of standardization in the maps of the western hemisphere.

At present the available maps of the world are of various scales, degrees of accuracy, size and format, and there is no broad and universal base for the delineation of the world's economic resources. Standard maps would give the peoples of the earth a common medium in which to express the physical features of each country and on which to plan its economic life.

The value of proper maps and charts to the various specialized agencies and international organizations cannot be over-emphasized. The work of these organizations would be greatly facilitated and accelerated by cartographic standardization, resulting in increased efficiency.

It is probably easier and more useful to achieve uniformity in small-scale maps, topographical and geographical; and it would be in them that uniform mapping and cartographic practices would, if established, be most effective.

The proposed cartographic organization could effect standardization in respect of the following:

- (a) Projection;
- (b) Scales;
- (c) Accuracy;
- (d) Symbols;
- (e) Lettering;
- (f) Size of sheets.

Standardization is likely to arouse a certain amount of opposition in almost all countries. In each country certain systems of scales, symbols and other cartographic representation have become hallowed by convention, and the change will, in many instances, cause considerable inconvenience, particularly during the transitional period; but such apparent disadvantages will pale into insignificance when it is realized that the ultimate effect tends towards concord and harmony, both national and international.

## CENTRAL RESEARCH ORGANIZATION

*submitted by the  
Delegation of Burma*

The original text of this paper appeared as document E/CONF.18/A/L.25, under the title "Questions Relating to a Central Research Organization or Office Where Problems Can Be Referred and from Which Up-to-date Information about Various Instruments May Be Obtained")

The need is growing steadily for a central international organization to which problems can be referred from which data on newer instruments can be obtained. This is a result of the ever-increasing demand for maps and charts of all types, both in developed and in under-developed countries.

The functions of the proposed research organization would include collection and collation from various national cartographic organizations of detailed and up-to-date reports on all developments. The benefit of this knowledge should then be at the disposal of all member countries. Similar data should be gathered from manufacturers of instruments. Any new developments should be evaluated by the research organization.

This office would thus be a central source of information and advice for the solution of problems, and a source of data in regard to methods and instruments which can be employed to the best advantage in a particular case.

We would suggest that this organization be established on lines similar to the European Organization for Experimental Photogrammetric Research, which has its headquarters in Delft, Netherlands, and maintains close collaboration with the International Training Centre for Aerial Survey. The difference between the two is that the proposed central research office would be a fully international organization, and with a much wider scope, including in its sphere of activities all fields of cartography.

The aim of the proposed official inter-governmental organization would be to speed up cartographic pro-

duction effectively, with an increase in accuracy and quality where desirable. To this end it should seek to remove obstacles to progress, and increase productive capacity of existing mapping organizations.

We have seen that experimental research by individual institutes or agencies, though of high intrinsic value, is by itself of little worth when improvement of cartographic production in the world as a whole, or even in one region of the world, is the desideratum. This is due to its limited scope.

This is particularly true of photogrammetry. Results obtained so far have been considered as fragmentary; and progress has not been in proportion to the vast mapping needs of the world.

Accordingly, the new organization's main activity would be the co-ordination of experimental work carried out in various countries, and the collecting of results of this work, which as far as possible should provide sufficient data for statistical treatment, so that conclusions may be drawn therefrom. Special attention needs to be paid to photogrammetric methods, in view of the rapidly increasing importance of modern photogrammetry.

It would furthermore be necessary to publish communications and scientific reports in an official review of the organization.

Such an organization would foster mutual co-operation, give added impetus to surveys, and increase the efficiency of cartographic institutions the world over.



## ANNEX

### Rules of Procedure<sup>1</sup>

#### I. REPRESENTATION AND CREDENTIALS

##### Rule 1

Each State participating in the Conference shall be represented by an accredited representative. If more than one representative is appointed, one of them shall be designated as the head of the delegation. Each delegation may also include such alternate representatives and advisers as may be required.

##### Rule 2

The credentials of representatives, alternate representatives and advisers shall be submitted to the Executive Secretary, if possible not later than twenty-four hours after the opening of the Conference. The credentials shall be issued either by the Head of the State or Government or by the Minister for Foreign Affairs.

##### Rule 3

The President and the Vice-Presidents of the Conference shall examine the credentials and report upon them to the Conference without delay.

##### Rule 4

Pending the decision of the Conference upon the report on credentials, the representatives, alternate representatives and advisers shall be entitled provisionally to be seated in the Conference.

#### II. AGENDA

##### Rule 5

The list of items set forth by the Secretariat<sup>2</sup> and communicated to the Governments invited to the Conference by the Secretary-General of the United Nations shall form the provisional agenda for the Conference. Any member of the Conference may propose any item for inclusion in the provisional agenda.

#### III. OFFICERS

##### Rule 6

The Conference shall elect a President, two Vice-Presidents and a Rapporteur from among the representatives of the States participating in the Conference.

##### Rule 7

The President shall preside over the plenary meetings of the Conference. He shall not vote but may designate another member of his delegation to vote in his place.

##### Rule 8

If the President is absent from a meeting or any part thereof, a Vice-President designated by him shall preside. A Vice-President acting as President shall have the same powers and duties as the President.

#### IV. SECRETARIAT

##### Rule 9

The Executive Secretary of the Conference appointed by the Secretary-General of the United Nations shall act in that capacity in all meetings of the Conference. He may appoint a deputy to take his place at any meeting.

##### Rule 10

The Executive Secretary or his representative may at any meeting make either oral or written statements concerning any question under consideration.

##### Rule 11

The Executive Secretary shall provide and direct such staff as is required by the Conference. He shall be responsible for making all necessary arrangements for meetings and generally shall perform all other work which the Conference may require.

#### V. CONDUCT OF BUSINESS

##### Rule 12

The majority of the members of the Conference shall constitute a quorum.

##### Rule 13

In addition to exercising the powers conferred upon him elsewhere by these rules, the President shall declare the opening and closing of each plenary meeting of the Conference, shall direct the discussion at such meetings, accord the right to speak, put questions to the vote and announce decisions. He shall rule on points of order and, subject to these rules of procedure, shall have complete control over the proceedings.

##### Rule 14

The President may, in the course of the discussion, propose to the Conference the closure of the list of speakers or the closure of the debate. He may also propose suspension or the adjournment of the meeting or the adjournment of the debate on the item under discussion. He may also call a speaker to order if his remarks are not relevant to the matter under discussion.

##### Rule 15

The President, in the exercise of his functions, shall act under the authority of the Conference.

<sup>1</sup> The provisional rules of procedure for the Conference were issued as document E/CONF.18/4.

<sup>2</sup> In document E/CONF.18/1.

## VI. VOTING

### Rule 16

During the discussion on any matter a representative at any time raise a point of order, and the point of order shall be immediately decided by the President in accordance with the rules of procedure. If the decision challenged by any representative it shall be immediately put to the vote of the Conference for decision and it shall stand unless overruled.<sup>a</sup> A representative raising a point of order may not speak on the substance of the matter under discussion.

### Rule 17

During the discussion of any matter a representative may move the adjournment of the debate on the item under discussion. Any such motion shall have priority. In addition to the proposer of the motion, one representative shall be allowed to speak in favour of, and one representative against, the motion.

### Rule 18

During the course of the debate, the President may announce the list of speakers and with the consent of the Conference declare the list closed. The President may, however, accord the right of reply to any member if, in his opinion, a speech delivered after he has declared the list closed makes this desirable. When the debate on an item is concluded because there are no other speakers, the President shall declare the debate closed. Such closure shall have the same effect as closure by the consent of the Conference.

### Rule 19

The President shall take the sense of the Conference on a motion for closure. If the Conference is in favour of the closure, the President shall declare the debate closed.

### Rule 20

The Conference may limit the time allowed for each speaker.

### Rule 21

Proposals and amendments shall normally be introduced in writing and handed to the Executive Secretary of the Conference, who shall circulate copies to the delegations. As a general rule no proposal shall be discussed or put to the vote at any meeting of the Conference unless copies of it have been circulated to all delegations not later than the day preceding the meeting. The President may, however, permit the discussion and consideration of amendments or motions as to procedure even though these amendments or motions have not been circulated or have only been circulated the same day.

### Rule 22

A motion may be withdrawn by its proposer at any time before voting on it has commenced, provided that the motion has not been amended. A motion which has thus been withdrawn may be reintroduced by any representative.

### Rule 23

When a proposal has been adopted or rejected, it may not be considered unless the Conference, by a two-thirds majority of the representatives present and voting, so decides. Permission to speak on the motion to reconsider shall be accorded only to two speakers opposing the motion, after which it shall be immediately put to the vote.

<sup>a</sup> See rule 24.

### Rule 24

Each State represented at the Conference shall have one vote, and the decisions of the Conference shall be made by a majority of the representatives of States participating in the Conference present and voting.

### Rule 25

For the purpose of these rules, the phrase "representatives present and voting" means representatives present and casting an affirmative or negative vote. Representatives who abstain from voting shall be considered as not voting.

### Rule 26

The Conference shall normally vote by show of hands, but any representative may request a roll-call. A roll-call shall be taken in the English alphabetical order of the names of the delegations at the Conference, beginning with the delegation whose name is drawn by lot by the President.

### Rule 27

After the President has announced the beginning of the vote, no representative shall interrupt the vote except on a point of order in connexion with the actual conduct of voting. Explanations of their votes by representatives may, however, be permitted by the President either before or after the voting. The President may limit the time to be allowed for such explanation.

### Rule 28

The Conference may, at the request of a representative, decide to put a proposal or an amendment to the vote in parts. If this is done the text resulting from the series of votes shall be put to the vote as a whole.

### Rule 29

When an amendment is moved to a proposal, the amendment shall be voted on first. When two or more amendments are moved to a proposal, the Conference shall first vote on the amendment furthest removed in substance from the original proposal and then on the amendment next furthest removed therefrom, and so on, until all the amendments shall be put to the vote. When, however, the adoption of one amendment necessarily implies the rejection of another amendment, the latter amendment shall not be put to the vote. If one or more amendments are adopted, the amended proposal shall then be voted upon. A motion is considered an amendment to a proposal if it merely adds to, deletes from or revises part of that proposal.

### Rule 30

If two or more proposals relate to the same question, the Conference shall, unless it decides otherwise, vote on the proposals in the order in which they have been submitted. The Conference may, after each vote on a proposal, decide whether to vote on the next proposal.

### Rule 31

All elections shall be decided by secret ballot unless otherwise decided by the Conference.

### Rule 32

If, when one person or one delegation is to be elected, no candidate obtains in the first ballot the majority required, a second ballot shall be taken, which shall be restricted

to the two candidates obtaining the largest number of votes. If in the second ballot the votes are equally divided, the President shall decide between the candidates by drawing lots.

In the case of a tie in the first ballot among the candidates obtaining the second largest number of votes, a special ballot shall be held for the purpose of reducing the number of candidates to two. In the case of a tie among three or more candidates obtaining the largest number of votes, a second ballot shall be held; if a tie results among more than two candidates, the number shall be reduced to two by lot.

#### *Rule 33*

If a vote is equally divided upon matters other than elections, a second vote shall be taken after an adjournment of the meeting for fifteen minutes. If this vote also results in equality, the proposal shall be regarded as rejected.

### VII. LANGUAGES

#### *Rule 34*

English and French shall be the working languages of the Conference.

#### *Rule 35*

Speeches made in either of the working languages shall be interpreted into the other working language. Speeches made in any one of the official languages of the United Nations shall be interpreted into the two working languages.

### VIII. RECORDS

#### *Rule 36*

Summary records of the plenary meetings of the Conference shall be kept by the Secretariat in the working languages. They shall be sent as soon as possible to all representatives, who shall inform the Secretariat within three

working days after the circulation of the summary records of any changes they wish to have made. Any disagreement concerning such changes shall be referred to the President of the Conference for decision.

### IX. PUBLICITY OF MEETINGS

#### *Rule 37*

The plenary meetings of the Conference and the meetings of its committees shall be held in public unless the body concerned decides that exceptional circumstances require that a particular meeting be held in private.

### X. COMMITTEES

#### *Rule 38*

The Conference may establish such committees as may be necessary for the performance of its functions. Items relating to the same category of subjects may be referred to the committee dealing with that category of subjects. Committees shall not introduce any item on their own initiative.

#### *Rule 39*

Each committee shall elect its own Chairman, Vice-Chairman and Rapporteur.

#### *Rule 40*

So far as they are applicable, the rules of procedure of the Conference shall apply to the proceedings of the committees. A committee may dispense with certain language interpretations.

### XI. AMENDMENTS

#### *Rule 41*

These rules of procedure may be amended by a decision of the Conference.

## International Co-operation on Cartography<sup>1</sup>

*The Economic and Social Council,*

*Having before it the report of the Secretary-General entitled "International Co-operation on Cartography"<sup>2</sup> and the report of the United Nations Regional Cartographic Conference for Asia and the Far East,<sup>3</sup>*

*Recognizing the importance of accurate and reliable cartographic information, more especially in connexion with economic development projects,*

*Noting the results of the Secretary-General's consultations with Governments and appropriate inter-governmental organizations on the adoption of a standard method of writing geographical names on maps, and on means for completion of the International Map of the World on the millionth scale,*

- 1. Commends the Conference for the work achieved;*
- 2. Draws the attention of Governments of Member States to the possibilities of requesting technical assistance in the field of cartography under the Expanded Programme of Technical Assistance;*
- 3. Recommends that those regional economic commissions which think it desirable consider the question of establishing cartographic committees for the purpose of periodic consultation among their members;*

Resolution 600 (XXI).

E/2823, Add. 1 and 2.

E/CONF.18/6 (United Nations publications, sales number: 1955 I.29).

### *4. Requests the Secretary-General:*

*(a) To draft, in co-operation with interested international organizations and such experts as he may wish to consult within the limits of budgetary availability, the general framework of a programme looking towards maximum international uniformity in the writing of geographical names, to submit it to Governments of States Members of the United Nations or members of the specialized agencies for their comments, and to report to the Council at a subsequent session;*

*(b) To prepare, on the basis of proposals already received, draft amendments to the existing specifications of the International Map of World on the millionth scale designed to allow the greatest possible flexibility, bearing in mind the need to maintain both the World Aeronautical Chart series of the International Civil Aviation Organization and the International Map, to submit the draft amendments to Governments of Member States concerned for their comments, and to report to the Council at a subsequent session;*

*5. Invites Governments of Member States to comment on the proposals and recommendations of the Secretary-General mentioned in paragraph 4 above;*

*6. Further request the Secretary-General to take the necessary steps to convene in 1958 in Tokyo a second regional cartographic conference for Asia and the Far East, including the preparation of a provisional agenda and the sending of invitations to Governments of States Members of the United Nations or members of the specialized agencies, and to the specialized agencies and other inter-governmental organizations.*

# SALES AGENTS FOR UNITED NATIONS PUBLICATIONS

- ARGENTINA**  
Editorial Sudamericana. S.A., Calle Abina 500, BUENOS AIRES
- AUSTRALIA**  
H.A. Goddard Pty., Ltd., 255a George Street, SYDNEY, N.S.W.; 90 Queen St., MELBOURNE, Victoria.  
Melbourne University Press CARLTON N.3 Victoria
- AUSTRIA**  
Gerold & Co., Graben 31, WIEN I.  
B. Wüllerstorff, Book Import and Subscription Agency, Markus Sittikusstrasse 10, SALZBURG
- BELGIUM**  
Agence et Messageries de la Presse, S.A., 14-22 rue du Persil, BRUSSELS.  
W. H. Smith & Son 71-75 bd Adolphe-Max, BRUSSELS
- BOLIVIA**  
Librería Selecciones, Empresa Editora "La Razón", Casilla 972, La Paz
- BRAZIL**  
Livreria Agir, Rua Mexico 98-B, Caixa Postal 1291, RIO DE JANEIRO, D.F.; and at SÃO PAULO and Belo Horizonte
- CAMBODIA**  
Papeterie-Librairie nouvelle Albert Portail, 14 av. Bouilloche, PHNOM-PENH
- CANADA**  
The Ryerson Press 299 Queen Street West, TORONTO, Ontario
- CEYLON**  
The Associated Newspapers of Ceylon, Ltd., Lake House, P.O. Box 244, COLOMBO
- CHILE**  
Librería Ivens, Casilla 205, SANTIAGO. Editorial del Pacífico, Ahumada 57, SANTIAGO.
- CHINA**  
The World Book Co., Ltd., 99 Chung King Road, 1st Section, TAIPEI, Taiwan.  
The Commercial Press, Ltd., 211 Honan Rd., SHANGHAI
- COLOMBIA**  
Librería América, Sr. Jaime Navarro R., 49-58 Calle 51, MEDELLIN.  
Librería Buchholz Galería, Av. Jiménez de Quesada 8-40, BOGOTÁ.  
Librería Nacional, Ltda., 20 de Julio, San Juan Jesús, BARRANQUILLA
- COSTA RICA**  
Trejos Hermanos Apartado 1313, SAN JOSÉ
- CUBA**  
La Casa Belga René de Smedt, O'Reilly 455, HAVANA
- CZECHOSLOVAKIA**  
Československý Spisovatel, Národní Trida 9, PRAGUE I.
- DENMARK**  
Messrs. Einar Munksgaard, Ltd., Nørregade 6, COPENHAGEN
- DOMINICAN REPUBLIC**  
Librería Dominicana, Calle Mercedes 49, Apartado 656 CIUDAD TRUJILLO
- ECUADOR**  
Librería Científica Bruno Moritz, Casilla 162, GUAYAQUIL; and at QUITO.
- EGYPT**  
Librairie "La Renaissance d'Egypte", 9 Sharia Adly Pasha, CAIRO
- EL SALVADOR**  
Manuel Navas y Cia., "La Casa del Libro Barato", 1ª Avenida Sur 37, SAN SALVADOR
- FINLAND**  
Akateeminen Kirjakauppa 2 Keskuskatu, HELSINKI.
- FRANCE**  
Editions A. Pedone, 13 rue Soufflot, PARIS V<sup>e</sup>.
- GERMANY**  
R. Eiseenschmidt, Kaiserstrasse 49, FRANKFURT/MAIN.  
Buchhandlung Elwert & Meurer, Hauptstrasse 101, BERLIN-SCHÖNEBERG.  
Alexander Horn, Spiegelgasse 9, WIESBADEN.  
W.E. Saabach, G.m.b.H., Ausland-Zeitungs-handel, Gertrudenstrasse 36, COLOGNE I.
- GREECE**  
Kauffmann Bookshop, 28 Stadion Street, ATHENS.
- GUATEMALA**  
Sociedad Económica Financiera, Edif. Briz, Do, 207, 6a Av. 14-33, Zona 1, GUATEMALA CITY.
- HAITI**  
Max Bouchereau, Librairie "A la Caravelle", Boite postale 111-B, PORT-AU-PRINCE
- HONDURAS**  
Librería Panamericana, Calle de la Fuente, TEGUCIGALPA
- HONG KONG**  
Swindon Book Co., 25 Nathan Road, KOWLOON
- ICELAND**  
Bókaverzlun Sigfusar Eymundssonar Austurstræti 18, REYKJAVIK.
- INDIA**  
Orient Longmans, CALCUTTA, BOMBAY, MADRAS and NEW DELHI.  
Oxford Book & Stationery Company, Scindia House, NEW DELHI, and at CALCUTTA.  
P. Varadachary & Co., 8 Linghi Chetty Street, MADRAS I.
- INDONESIA**  
Jajasan Pembangunan, Gunung Sahari 84, DJAKARTA.
- IRAN**  
"Guity", 482 av. Ferdowsi, TEHERAN
- IRAQ**  
Mackenzie's Bookshop, Booksellers and Stationers, BAGHDAD
- ISRAEL**  
Blumstein's Bookstores, Ltd., 35 Allenby Road, P.O.B. 4154, TEL AVIV.
- ITALY**  
Libreria Commissionaria Sansoni Via Gino Capponi 26, FLORENCE.
- JAPAN**  
Maruzen Co., Ltd., 6 Tori-Nichome, Nihonbashi, P.O.B. 605, TOKYO Central.
- JORDAN**  
Joseph & Bahous & Company Dar-El-Kutub, P.O. Box 66, AMMAN
- LEBANON**  
Librairie Universelle, BEIRUT
- LIBERIA**  
Mr. Jacob Momolu Kamara Curly and Front Streets, MONROVIA.
- LUXEMBOURG**  
Librairie J. Schummer, Place Guillaume, LUXEMBOURG.
- MEXICO**  
Editorial Hermes S.A. Ignacio Mariscal 41, MEXICO, D.F.
- NETHERLANDS**  
N. V. Martinus Nijhoff, Lange Voorhout 9, THE HAGUE.
- NEW ZEALAND**  
The United Nations Association of New Zealand, G.P.O. 1011, WELLINGTON
- NORWAY**  
Johan Grundt Tanum Forlag, Kr. Augustsgt 7a, OSLO
- PAKISTAN**  
Thomas & Thomas, Fort Mansion, Frere Road, KARACHI.  
Publishers United, Ltd., 176 Anarkali, LAHORE.  
The Pakistan Co-operative Book Society, 150 Govt. New Market, AZIMPURA, Dacca, East Pakistan, and at CHITTAGONG.
- PANAMA**  
José Menéndez, Agencia Internacional de Publicaciones Plaza de Arango, PANAMA
- PARAGUAY**  
Agencia de Librerías de Salvador Nizza, Calle Pie. Franco 39-43, ASUNCION
- PERU**  
Librería Internacional del Peru S.A. Casilla 1417, LIMA; and at AREQUIPA.
- PHILIPPINES**  
Alema's Book Store, 749 Rizal Avenue, MANILA.
- PORTUGAL**  
Livreria Rodrigues, Rua Auréa 156-188, LISBON.
- SINGAPORE**  
The City Bookstore, Ltd., Winchester House Collyer Quay, SINGAPORE
- SPAIN**  
Librería José Bosch, Ronda Universidad 11, BARCELONA.  
Librería Mundi-Prensa, Lagasca 38, MADRID
- SWEDEN**  
C. E. Fritze's Kungl. Hovbokhandel Fredsgatan 2, STOCKHOLM 16
- SWITZERLAND**  
Librairie Payot, S.A., 1 rue de Bourg LAUSANNE; and at BASLE, BERNE, GENEVA, MONTRÉUX, NEUCHÂTEL, VEVEY, ZÜRICH.  
Librairie Hans Raunhardt, Kirchgasse 17, ZÜRICH I.
- SYRIA**  
Librairie universelle, DAMASCUS
- THAILAND**  
Pramuan Mit, Ltd., 55, 57, 59 Chakrawat Road, Wat Tuk, BANGKOK.
- TURKEY**  
Librairie Hachette, 469 Istiklal Caddesi, BEYOGLU-ISTANBUL.
- UNION OF SOUTH AFRICA**  
Van Schaik's Bookstore (Pty.) P.O. Box 724, PRETORIA.
- UNITED KINGDOM**  
H.M. Stationery Office, P.O. Box 569, LONDON S.E.1; and at H.M.S.O. Shops in LONDON, BELFAST, BIRMINGHAM, BRISTOL, CARDIFF, EDINBURGH and MANCHESTER
- UNITED STATES OF AMERICA**  
International Documents Service, Columbia University Press, 2960 Broadway, NEW YORK 27, N.Y.
- URUGUAY**  
Oficina de Representación de Editoriales, Prof. Héctor d'Elia, 18 de Julio 1333, Palacio Díaz, MONTEVIDEO.
- VENEZUELA**  
Librería del Este, Av. Miranda 52, Edif. GALIPAN, CARACAS
- VIETNAM**  
Librairie Albert Portail, 185-193 rue Catinaut, SAIGON.
- YUGOSLAVIA**  
Drzavno Preduzecce, Jugoslovanska Knjiga, Terazije 27/11, BELGRADE.  
Cankar's Endowment (Cankarjeva Zalozba) LJUBLJANA (Slovenia).

XII 56

Orders from countries where sales agents have not yet been appointed may be sent to

Sales Section, European Office of the United Nations,  
Palais des Nations, GENEVA, Switzerland

Sales and Circulation Section, United Nations,  
NEW YORK, U.S.A.

Printed in Belgium

24118—September 1957—2,725

Price : \$(U.S.) 1.50; 11/- stg.; Sw. fr. 6.50  
(or equivalent in other currencies)

United Nations publication

Sales No. : 1956.123