REPORT ON THE FIRST SURVEY

FOR

TELECOMMUNICATIONS AND BROADCASTING NETWORK

EXPANSION PROJECT

IN CAMBODIA

MAY 1970

OVERSEAS TECHNICAL COOPERATION AGENCY

GOVERNMENT OF JAPAN

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P R E F A C E

The Government of Japan, at the request of the Government of Cambodia, decided to undertake a feasibility survey for Telecommunications and Broadcasting Expansion Project in Cambodia, and entrusted this task to the Overseas Technical Cooperation Agency (OTCA), an institution for implementing technical cooperation activities on government basis.

The agency immediately organized a survey team, and dispatched it to Cambodia to carry out a preliminary survey to study the feasibility of an expansion project for a nation-wide microwave, television and radio broadcasting network.

For period of 49 days beginning on December 7, 1969, the survey team, consisting of 6 experts headed by Mr. Yasuo Otaki, (Deputy Head of Technical Investigation Division, Radio Regulatory Bureau, Ministry of Posts and Telecommunications) engaged in a number of discussions with the Government officials of Cambodia, performed field investigations and collected the necessary data for planning the project.

The report hereby presented is based on the outcome of the abovementioned preliminary survey.

It would be most gratifying to the Agency if this report could contribute to the development of communication in Cambodia and to the betterment of the mutual friendship and economic cooperation between our two countries.

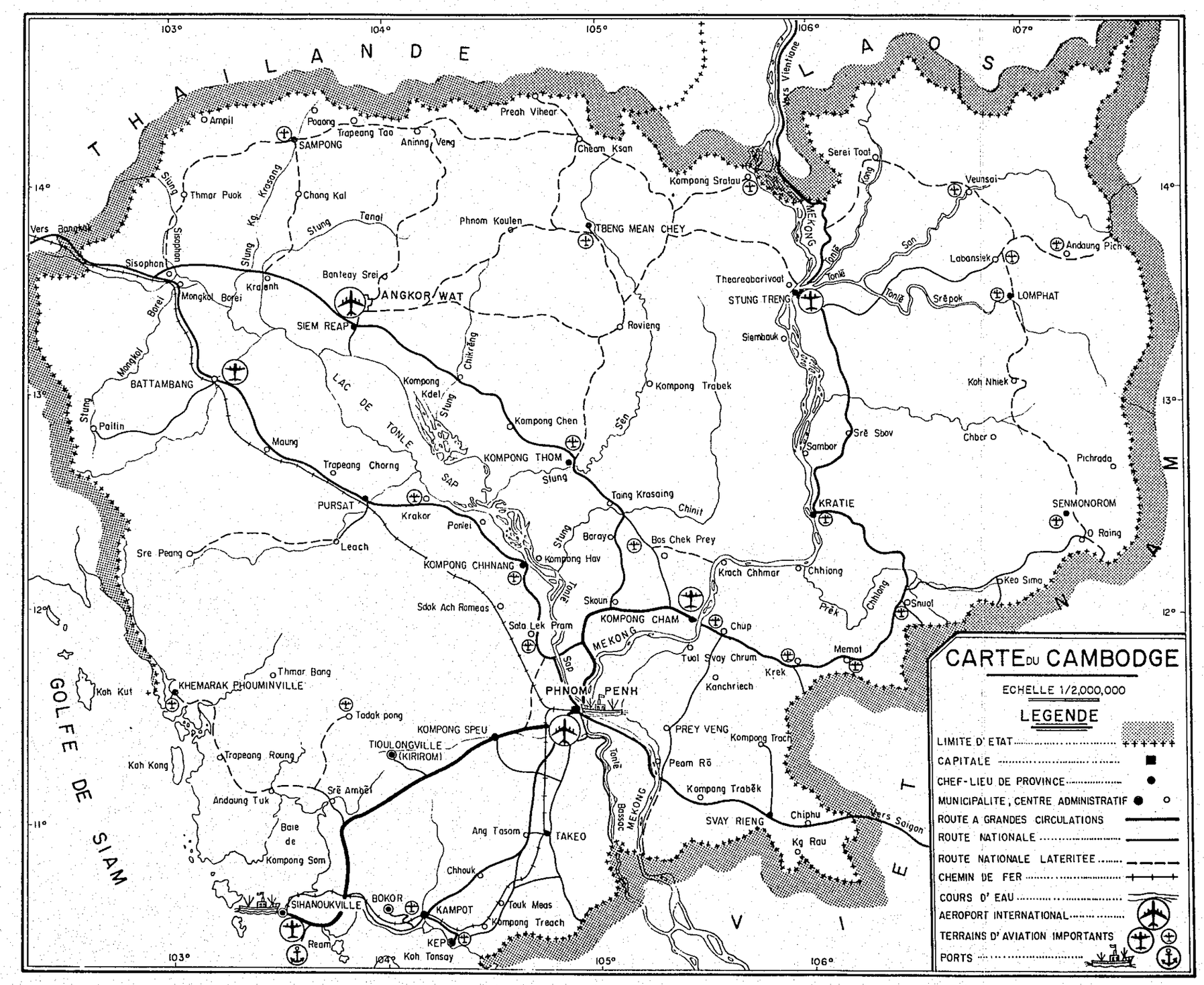
I take this opportunity to express my hearty thanks to the officials of the Government of Cambodia for the valuable assistance and support they extended to the team.

May 1970

K. Tatsuke

Keiichi Tatsuke
Director General
Overseas Technical Cooperation Agency

C O N T E N T S


THAILANDE
LAOS
VIETNAM
GOLFE DE SIAM
103°
104°
105°
106°
107°
14°
13°
12°
11°
Vers Bangkok
Ampil
Poipet
Trapeang Tao
SAMPONG
Aninng Veng
Preah Vihear
Cheam Ksan
Vers Vientiane
Serei Toat
Veunsai
Thmar Puok
Chang Kal
Stung Krasang
Stung Tanal
Phnom Koulen
TBENG MEAN CHEY
Kompong Sralau
MEKONG
Tonlé San
Labansiek
Andaung Pich
Sisophon
Banteay Srei
ANGKOR WAT
Kralanh
Mongkol Borei
SIEM REAP
Rovieng
Theareabarivoat
STUNG TRENG
Srépok
LOMPHAT
Siembauk
BATTAMBANG
Paitin
Stung Mongkol
LAC DE TONLE SAP
Kompong Kdei
Chikréng
Kompong Trabek
Koh Nhiek
Maung
Trapeang Chorng
KOMPONG THOM
Kompong Chen
Sen
Sambor
Srê Sbov
Chber
Pichrada
PURSAT
Krakor
Ponlei
Taing Krasaing
Chinit
KRATIE
SENMONOROM
Baray
Bos Chek Prey
Kompong Hav
KOMPONG CHHNANG
Krach Chhmar
Chhiong
Raing
Keo Sima
Sre Peang
Leach
Sdok Ach Romeas
Skoun
Prêk Chhlong
Snuol
Sata Lek Pram
KOMPONG CHAM
Chup
Memot
Tuol Svay Chrum
Krek
Kanchriech
KHEMARAK PHOUMINVILLE
Koh Kut
Thmar Bang
PHNOM PENH
Tadak pong
KOMPONG SPEU
TIOULONGVILLE (KIRIROM)
PREY VENG
Kompong Trach
Peam Rō
Trapeang Roung
Koh Kong
Srê Ambel
Andaung Tuk
Kompong Trabêk
Chiphu
Vers Saigon
SVAY RIENG
Kg Rau
Baie de Kompong Som
Ang Tasom
TAKEO
Bassac MEKONG
Chhouk
SIHANOUKVILLE
BOKOR
KAMPOT
Touk Meas
Kompong Treach
Ream
KEP
Koh Tonsay
CARTE DU CAMBODGE
ECHELLE 1/2,000,000
LEGENDE
LIMITE D' ETAT
CAPITALE
CHEF-LIEU DE PROVINCE
MUNICIPALITE, CENTRE ADMINISTRATIF
ROUTE A GRANDES CIRCULATIONS
ROUTE NATIONALE
ROUTE NATIONALE LATERITEE
CHEMIN DE FER
COURS D' EAU
AEROPORT INTERNATIONAL
TERRAINS D' AVIATION IMPORTANTS
PORTS

List of Abbreviations

This list enumerates the abbreviations used in this report.

Abbreviation	
C.C.I.R.	International Radio Consultative Committee (I.T.U.)
C.C.I.T.T.	International Telegraph and Telephone Consultative Committee (I.T.U.)
I.T.U.	International Telecommunication Union
F.C.C.	Federal Communications Commission (U.S.A.)
E.R.P.	Effective Radiated Power
VHF	Very High Frequency
UHF	Ultra High Frequency
M.P.T.	Ministère des Postes et Télécommunications
P.T.	Postes et Télécommunications
M.I.	Ministère de l'Information
M.T.P.	Ministère des Travaux Publics
F.A.R.K.	Forces Armées Royales Khméres
E.D.C.	Electricité du Cambodge

I SUMMARY

1 Purpose of Investigation

At the request of the Royal Cambodia Government, our survey team conducted the first survey to contribute to the formulation of the expansion project of the Nation-wide Microwave Network and TV, Radio Broadcasting Network in Royal Cambodia.

2 Organization of the First Survey Team

The First Telecommunications and Broadcasting Survey Team to Royal Cambodia was organized by the Overseas Technical Cooperation Agency in December, 1969. Members were:

Team Chief	YASUO OTAKI Deputy Head of Technical Investigation Division, Radio Regulatory Bureau, Ministry of Posts and Telecommunications
Member	YUKIO MIYAZU Staff Engineer Frequency Division, Radio Regulatory Bureau, Ministry of Posts and Telecommunications
Member	YOSHIO NAKANO Staff Engineer International Affairs Office, Nippon Telegraph and Telephone Public Corporation (N.T.T.)
Member	YOICHI JUICHIYA Staff Engineer International Affairs Office, Nippon Telegraph and Telephone Public Corporation (N.T.T.)
Member	NORIO IGARASHI Staff Engineer Planning Office, Headquarters of Technical Administration and Construction, Japan Broadcasting Corporation (N.H.K.)
Member	HIROSHI KAI Coordinator Finance Section, Account and Finance Division, Overseas Technical Cooperation Agency (O.T.C.A.)

3 Schedule

The survey team arrived in Phnom Penh on December 7th, 1969.

After discussing with the Ministère des Postes et Télécommunications, the

Ministère de l'Information etc., and preparing for the field survey, the survey team conducted the field survey for the site selection of the 41 proposed sites, including Phnom Penh, from December 18th, 1969 until January 14th, 1970. The team left Phnom Penh on January 24th, 1970.

An interim report was prepared on the result of this survey and submitted to the Ministère de l'Information on January 21st, and to the Ministère des Postes et Télécommunications on January 22nd. Discussions were held with them on the result of this survey and future problems.

A detailed schedule of this survey is shown in Table I-1.

Table I-1 Survey Schedule

Date	Schedule
Dec. 7, Sun.	Arrival in Phnom Penh
8, Mon.	Meeting with Japanese Embassy personnel Meeting with Ministère des Postes et Télécommunications
9, Tue.	Meeting with Ministère de l'Information Observation of TV station Purchase of maps from F.A.R.K.
10, Wed.	Droit de l'homme
11, Thu.	Reception of unaccompanied baggage Discussion with M.P.T. Observation of Telephone Exchange
12, Fri.	Meeting with Ministère de Plan Observation of the Centres des Reception et Emission des Télécommunications Internationales
13, Sat.	Meeting with Electricité du Cambodge
14, Sun.	Pre-survey of Phnom Penh -- KG. Cham route
15, Mon.	Meeting with Energie Dep. des Travaux Publics Discussion with M.I.
16, Tue.	Discussion with Radiodiffusion Bureau de M.I. Observation of Emetteurs de Radiodiffusion
17, Wed.	Meeting and preparation for the first field survey (Phnom Penh -- Stung Treng route) Negotiation with Custom Director for air-cargo
18, Thu.	Departure for the first survey Mirror test of Phnom Penh -- Batheay -- KG. Cham route Reception, opening and checking of air-cargo
19, Fri.	Field survey of Phnom Penh, rubber plantation in Suong and Chhlong

Dec.20, Sat. Field survey of Kratie -- Stung Treng route
Two Survey Team members were arrested in the jungle by F.A.R.K., but they were released at the headquarters in Stung Treng after explanation of survey purpose.

21, Sun. Field survey of Kratie -- KG. Cham route
Arrival in Phnom Penh
Meeting with Japanese Embassy personnel about the arrest

22, Mon. Arrangement of data in the first field survey
Meeting with M.P.T. about the arrest

23, Tue. Compensatory day-off in place of the 21st

24, Wed. Meeting and preparation for the second field survey
(Phnom Penh -- Battambang -- Siem reap route)

25, Thu. Departure for the second survey
KG. Chhnang, Pursat, and Battambang

26, Fri. Field survey in Battambang

27, Sat. Field survey at Phnom Tippedy
Congrès National (27th -- 30th)

28, Sun. Mirror test of Phnom Penh -- Batheay -- KG.Chhnang route

29, Mon. Meeting with Japanese Embassy personnel

30, Tue. Field survey in KG.Thom

31, Wed. Field survey in Siem reap

1970
Jan. 1, Thu. New Year Holiday

2, Fri. Arrival in Phnom Penh

3, Sat. Arrangement of data in the second field survey
Discussion on survey results with M.P.T. and M.I.
Meeting with Meteorologie Dep. de M.T.P.

4, Sun. Holiday

5, Mon. Meeting and preparation for the third field survey
(Phnom Penh -- Takeo -- Kampot -- Bokor -- Sihanoukville route)

6, Tue. Departure for the third survey
Field survey in Takeo, Kampot and Kep

7, Wed. Field survey in Bokor and Sihanoukville

8, Thu. Mirror test and propagation test for VHF between Bokor and Sihanoukville

9, Fri. Mirror test and propagation test for VHF between Bokor and Kampot
Preliminary survey at Ph. Dambok Khops

10, Sat. Mirror test between Bokor, Ph. Dambauk Khpos and Takeo

11, Sun. Holiday

12, Mon. Field survey in KG. Speu and Ph. Ta Mouk

13, Tue. Field survey in Svay Rieng, Prey Veng and Ba Phnom

14, Wed. Arrangement of data in the third field survey

15, Thu. Meeting with M.P.T. and M.I.

16, Fri. Drawing up the interim report

17, Sat. Drawing up the interim report
Observation of Kirirom hydro-electric power station and
Prek Thnot dam

18, Sun. Holiday

19, Mon. Drawing up the interim report
Arrangement for return of equipment

20, Tue. Meeting at the Embassy of Japan
Field survey at Chambak
Procedure for return of air cargo

21, Wed. Interim meeting at Ministère de l'Information

22, Thu. Interim meeting at Ministère des Postes et Télécommunications

23, Fri. Salution and preparation for leaving

24, Sat. Departure from Phnom Penh

4 Investigation Outline

4.1 Scope

(1) Basic site selection survey in support of the Nation-wide Microwave Network construction project for interurban telegraph and telephone circuits and transmission circuits to carry TV and radio programs linking the capital city, Phnom Penh, to local major cities.

(2) Basic site selection survey in support of the TV and radio broadcasting station construction project for nation-wide service with good receiving quality.

(3) Rough estimate of the cost required for the construction

4.2 Microwave Network

For the formulation of the nation-wide microwave network construction project aimed at linking Phnom Penh, the capital city of Cambodia, with local major cities, a field survey was made on the 41 proposed sites of relay stations covering 4 major routes. Prior to the field survey, map studies were made on maps scaled at 1:250,000, 1:100,000 and 1:50,000 respectively, and, as a result, many proposed relay station sites were selected. However, with the advice of officials of the Royal Cambodia Government, 41 most favorable proposed sites were selected. Then, for each of these selected sites, surveys were made for access road, power supply and weather condition. Mirror tests were also conducted for major relay sections. Surveys were also made on the current telecommunication and broadcasting setup in major local cities.

In the progress of social activities such as politics, economy and culture, the demand for telephone circuits is expected to grow even more. For this reason, the major trunk lines must be of high quality and must have a greater transmission capacity. Also, in view of the future linkage to international telephone circuits, the standard of these telecommunications must conform to C.C.I.R. and C.C.I.T.T. Recommendations. Improvement of the quality of telecommunications with the use of these standards will further simulate and accelerate the demand for telecommunications.

The radio channels are to consist of two radio channels for telephone, one regular radio channel and one stand-by radio channel. Transmission capacity is to be 600 telephone channels. For the transmission of TV broadcasting program, no other radio channel is to be provided, but the stand-by radio channel is to be economically used for TV in view of very short TV broadcasting hours. It will be necessary to provide means to allow ready installation of an additional regular radio channel for the transmission of TV broadcasting program in the event that the broadcasting hours are expanded in the future.

Because of the topography of Royal Cambodia, which extends over a vast plain centering on Tonle Sap and the Mekong, the reflecting points are located on the water surface or rice paddies in most of the relay sections of the microwave network. Moreover, because of lack of appropriate hills or mountains which could be used as shielding ridge, attenuation of reflected wave is not expected. In view of difficulties in selecting hills or mountains suitable for microwave relay, it will be inevitable to construct antennas on the flat land along the road with low propagation path, and the occurrence of deep fading is anticipated.

Selection of frequency band to be used is a very important matter and it is considered proper that the decision be made after a full study has been made on the result of propagation tests. If a broad judgement is to be made at the present stage, it is considered most desirable to use the 2 GHz band, which provides stable propagation, and to make the propagation distance as short as possible. For the relay section where propagation is to be made over a long distance on the water surface, adoption of 400 MHz will be unavoidable.

Based on the result of the selection of station sites, the microwave transmission network conceivable at the present stage is as shown in Fig. II-1.

Construction cost of this project is estimated at 338,800,000 Riel.

4.3 Television Broadcasting Network

To establish a nation-wide television broadcasting network, it will be necessary to provide now television broadcasting stations in Battambang, KG.Thom, Boker, Svay Rieng, KG. Cham, Kratie, Pursat and Siemreap, in addition to the existing television broadcasting station in Phnom Penh. By these provisions, it will be possible to establish a single network of television service for the whole nation.

Service area and coverage, for the existing station in Phnom Penh and 8 additional stations, are shown in Fig. III-1 and Table III-1. With these stations, it will be possible to provide TV broadcasting service to about 95% of the whole population of Cambodia.

For TV standard, it is advisable to adopt the M system as reported by C.C.I.R., and, for the frequency, it is desirable to use FCC channels in Band III of the VHF band. Specifications for 8 additional stations are shown in Table III-2.

For color television broadcasting, it would be appropriate to inaugurate broadcasting at the time when the social and economical conditions have been further improved in the future.

For relaying television programs, use of a microwave network is most desirable to maintain satisfactory transmission quality.

However, for the route where establishment of a microwave network is not considered appropriate for radio wave propagation, adoption of the rebroadcast system will be required.

For the Battambang-Siemreap route with a long distance water surface propagation path, the rebroadcast system must be used. For the Phnom Penh-Bokor route, there also is a possibility of economical use of rebroadcast system. However, as this route requires a long distance propagation extending about 140 km, the use of a rebroadcast system must be decided after making careful studies on the result of the receiving test which will have to be made over a long period of time during the second survey.

As it is advisable to provide a UHF relay for the KG. Chhnang-KG. Thom route from the standpoint of providing better radio wave propagation. A receiving test from Phnom Penh of the braodcast wave will have to be similarly made at KG. Chhnang.

Construction cost of this project is estimated at 111,000,000 Riel.

4.4 Radio Broadcasting Network

As the popularization of radio sets is remarkable throughout the country, the role of the radio in such fields as the conveyance of information, the spread of education and providing entertainment for the public is very important and the use of the radio in providing information service is considered highly effective.

As a result of a survey on the service area covered by the existing broadcasting stations in Phnom Penh, Battambang and Kep, it is estimated that these stations cover about 80% of the total population. Under the construction project of

Ministère de l'Information for 1970, the transmitting power of the Phnom Penh station is to be increased to 200 kW and that of the Battambang Station to 10 kW. A 1 kW transmitter is to be newly installed at the Kratie station. When these projects are completed, the service area is expected to increase to about 87%.

These service areas and coverage are shown in Fig. IV-1, Fig. IV-2, Table IV-2 and Table IV-3. It will also be necessary in the future to provide stations in Sihanoukville and Stung Treng for further expansion of the radio network.

5 Conclusion

This survey was carried out within a very short period of only 49 days and was obliged to terminate the basic survey, as the scope of this survey was extended to include Microwave Network, Television Broadcasting Network and Radio Broadcasting Network.

As mentioned above, the nation-wide field survey of 41 proposed sites was carried out, the mirror test was conducted on as many sections as possible and, moreover, the map survey was conducted in detail.

The primary construction project plan for microwave, television and radio broadcasting networks was drawn up based on these survey results.

6 Acknowledgement

This first investigation was conducted with the all-out cooperation of the persons concerned of Ministère des Postes et Télécommunications, and Ministère de l'Information.

As the governor of every Khet gave us the most generous support during the field survey, we were able to attain smoothly the purpose of the investigation without serious incident.

The staff of Ministère des Travaux Publics, Ministère du Plan, the Service Geographique des F.A.R.K., and Electricité du Cambodge furnished us much direct and indirect cooperation and supplied us with various data required for the investigation.

The Hon. K. Chikaraishi, Japanese Ambassador in Royal Cambodia, Mr. M. Sakayanagi, Second Secretary of the Embassy of Japan in Roayl Cambodia, other Embassy Staff Personnel, and Japanese Telecommunications and Broadcasting Experts of the Colombo Plan, provided us with their superior guidance and assistance throughout the whole investigation period.

We appreciate the official and private cooperations of many other people of Royal Cambodia.

We wish to express our hearty gratitude to all of them and hope that this investigation will contribute to the improvement of telecommunications and broadcasting conditions, further development of economy and the elevation of culture in Royal Cambodia and serve in the promotion of amicable relations between Roayl Cambodia and Japan.

II MICROWAVE NETWORK

1 Design Standards

Each planned network between Phnom Penh ~Battambang, Phnom Penh~ Sihanoukville, Phnom Penh~ Svay Rieng and Phnom Penh ~Stung Treng embodies the possibility of forming part of an international circuit to Thailand, Vietnam and Laos, respectively, in the future. On the other hand, formed into a nation-wide network, these networks are used for the national back-bone route in Cambodia. Therefore, network design standards should conform with the relevant C.C.I.R. or C.C.I.T.T. recommendations. It is desirable that, on the other domestic network, design standards should be established in Cambodia which will be able to be realized easily from the technical and economical point of view, as long as the toll call quality does not deteriorate.

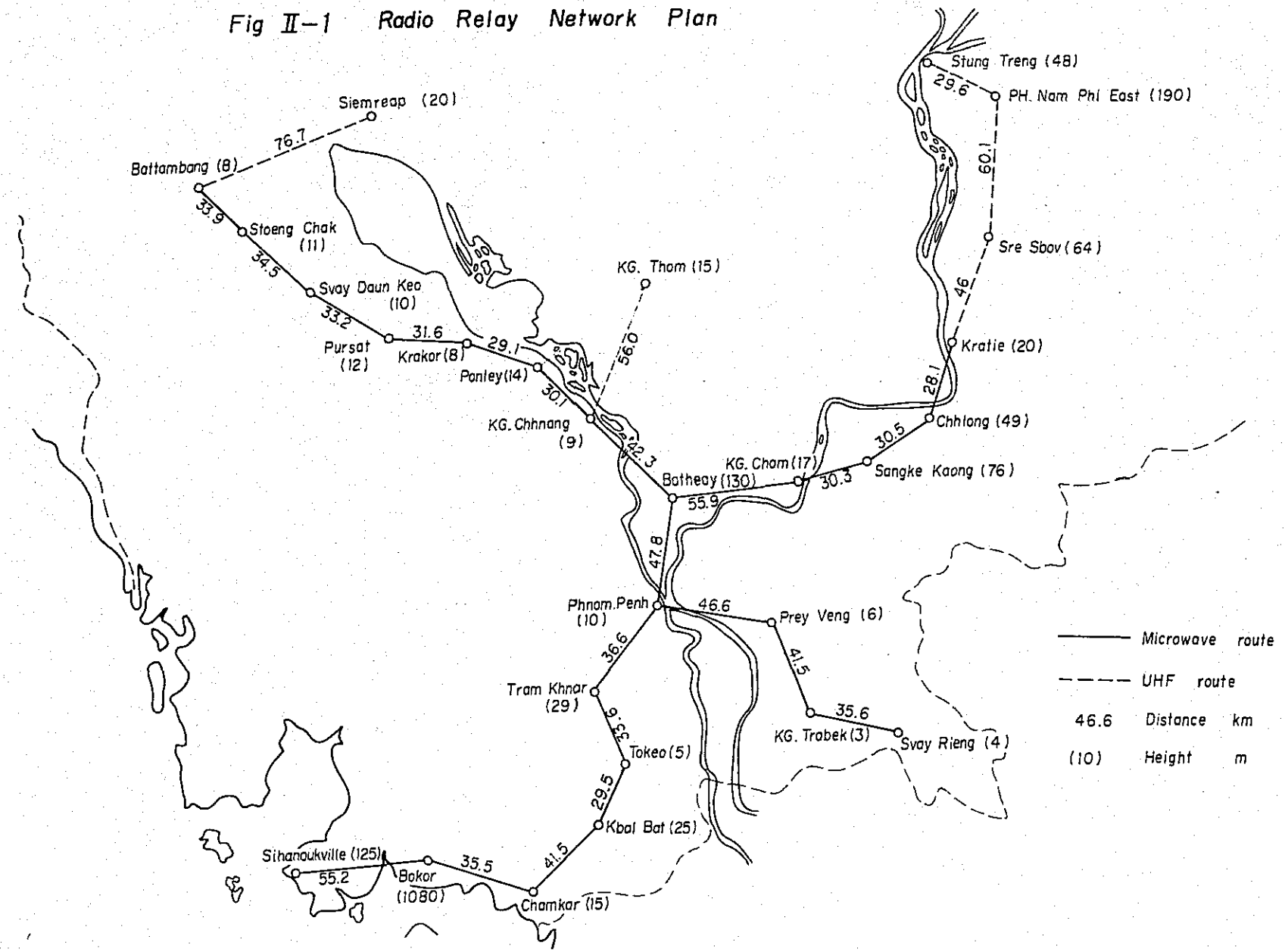
Design standards on noise power in a telephone channel, which is very important in planning the telecommunication network, should conform with C.C.I.R. Recommendation 395-1. The design standards in this Recommendation may be realized on the microwave relay system, but are impossible on the UHF relay system for economical reasons. Therefore, it is necessary to lower standards, when using UHF. In this case, allowable noise power objective per one UHF repeater section is considered 5,000 pW, which does not disturb the circuit quality and can easily be realized on an economical basis.

If, in the future, an international circuit will be required for the network which is using UHF at that time, a microwave relay system will need to be constructed in exchange for UHF relay system. After that, the complete international network will satisfy the design standards that conform with the C.C.I.R. Recommendations.

Design standards for the transmission of television signals over long distances should conform with C.C.I.R. Recommendation 421-1.

Transmission of color television signals through the network is not considered in this report, because the plans are not settled in Cambodia. But, if transmission of color television signals in Cambodia will be required, there will be no problems involved. It is considered that a television circuit which is designed to be able to transmit monochrome television signals for circuits 2,500 km long, will encounter no trouble in transmitting color television signals over the longest transmission distances in Cambodia, although it is natural that design objectives for the transmission of color television signals are more severe than objectives for monochorme television signals.

Fig II-1 Radio Relay Network Plan



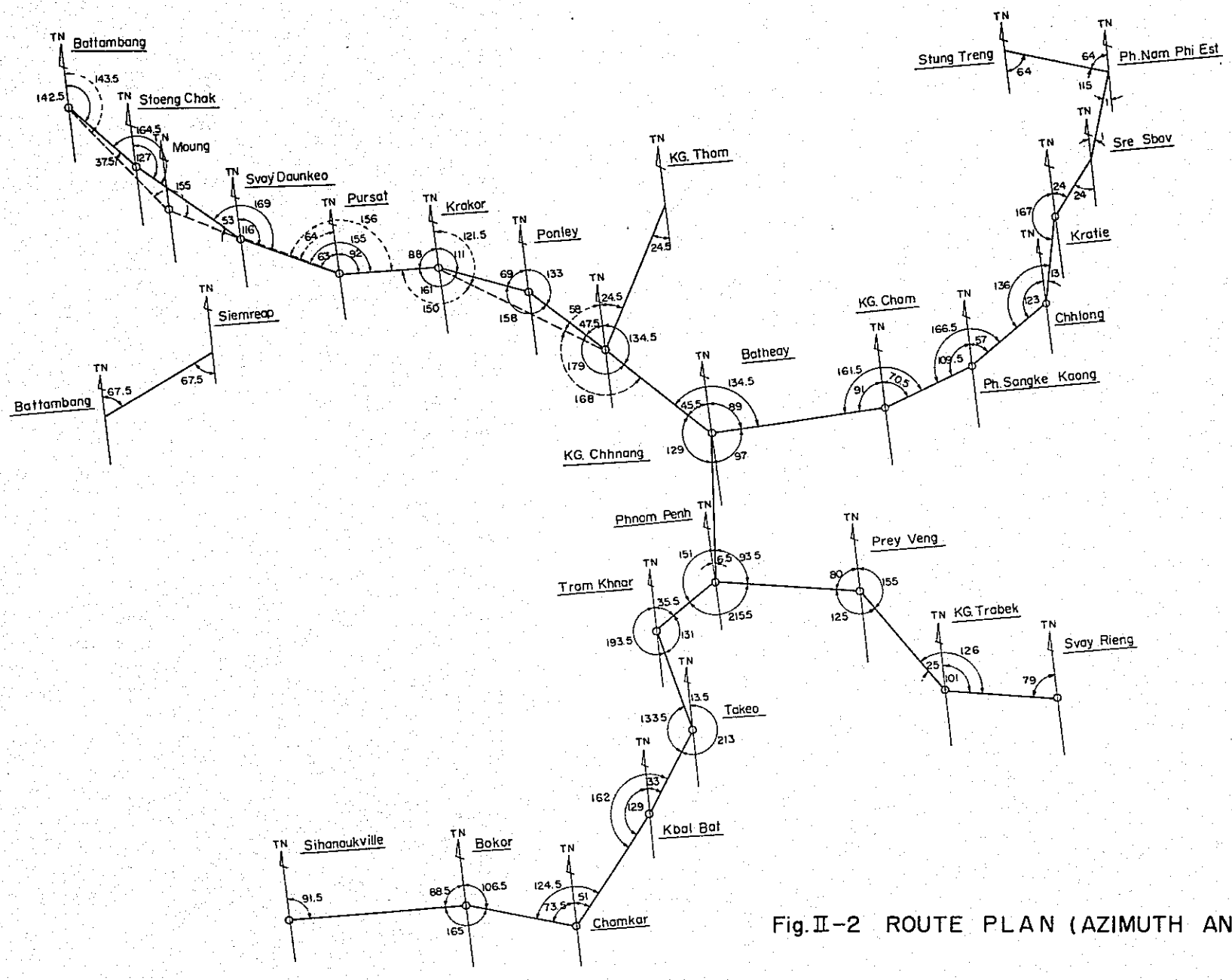


Fig. II-2 ROUTE PLAN (AZIMUTH ANGLE)

2 Transmission Capacity and System Composition

2.1 Traffic Forecast

Toll calls are classified into departure, arrival and transit call. These are summed up and their number is published monthly. According to the annual report of 1968, the number of toll calls in 1968 increase by 37%, compared with 1967. It may be adequate for the staffs of M.P.T. to estimate the increasing factor per year of toll call as 15%.

Assuming an increasing factor of 10% per year, the number of toll calls after ten years will be 2.6 times, and assuming 15% or 20% per year, it will be four or six times, respectively.

Table II-1 shows the maximum number of toll calls in one month (within five months, from July 1969 till November 1969) on the local telephone offices where many toll calls are handled, and the number of direct circuits between Phnom Penh and the local telephone offices.

Table II-1 Number of Toll Call

Telephone Office	Number of Toll Call (Jul. ~Nov., 1969)			Number of Circuit
	Departure	Arrival	Transit	
Kompong Cham	1 4,228	1 4,017	2,679	6
Sihanoukville	2 3,786	3 2,587	-	8
Battambang	3 2,006	4 2,407	349	3
Kampot	4 1,994	6 1,993	1,122	3
Siemreap	5 1,942	2 2,608	29	2
Takhmau	6 1,674	5 2,035	65	1
Prey Veng	7 1,399	9 1,273	9	2
Kompong Speu	8 1,249	7 1,419	1,284	1
Svay Rieng	9 1,992	10 1,104	-	1
Takeo	10 991	11 1,035	137	1
Kompong Thom	11 961	12 771	45	1
Suong	12 953	8 1,269	10	-
Kirrirom	13 946	15 512	-	1
Mimot	14 603	14 542	173	1
Kompong Chhnang	15 525	13 758	33	1

Note : Number of toll call shows that of the maximum of month.

Toll calls are mainly made between Phnom Penh and other local cities, and there is little traffic among the cities themselves. It is estimated that 80 % number of departure and arrival of toll calls in each city, except for Phnom Penh,

are calls from and to Phnom Penh. Therefore, it is desirable first to construct direct circuits between Phnom Penh and each main city.

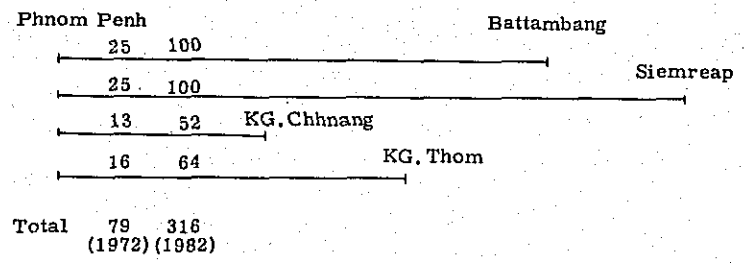
Though there seems to be a balance between the few toll circuits and present toll call demand, it appears that there are many latent demands induced by improvement of speech quality (especially in long distance call) and reduction of waiting time after the development of the telecommunication network.

Accordingly, it is very difficult to forecast the traffic demand because there are possibilities that toll calls will expand largely through the development of economy and culture, and the snowball effects that may be caused by the increasing number of local telephone sets.

Table II-2 shows an example of estimation on the necessary direct circuits between Phnom Penh and other cities.

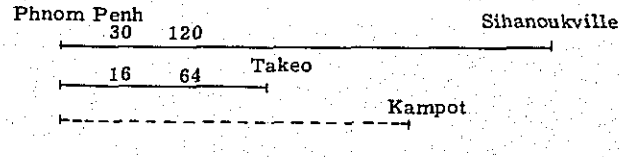
Table II-2 Number of Toll Telephone Circuit

(1) Phnom Penh ~ Battambang ~ Siemreap



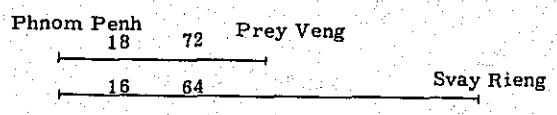
	(1972)	(1982)
Total	79	316

(2) Phnom Penh ~ Sihanoukville



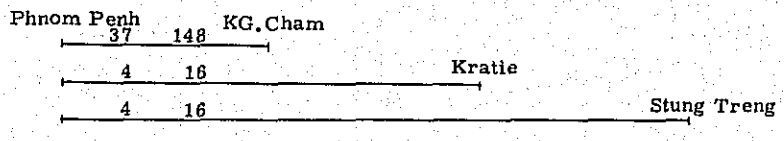
	(1972)	(1982)
Total	46	184

(3) Phnom Penh ~ Svay Rieng



	(1972)	(1982)
Total	34	136

(4) Phnom Penh ~ KG. Cham ~ Kratie ~ Stung Treng.



	(1972)	(1982)
Total	45	186

2.2 Transmission Capacity

When using the microwave relay system, it is possible to transmit a large capacity of toll telephone channels or television signals. It is considered that the transmission of monochrome television signals is equivalent to that of 600 telephone channels.

If there are telephone and television bearers through microwave relay system and trouble occurs, a stand-by bearer must transmit signals for telephone or television as the case stands, respectively. Accordingly, transmission capacity for the stand-by bearer needs 600 telephone channels or the equivalent. From a maintenance point of view, it is desirable that all radio equipment can be used commonly for all bearers. For this reason, for transmission of television signals, the transmission capacity of one bearer must be over 600 telephone channels or the equivalent. When television signals are not transmitted, such a limitation does not exist.

When using the UHF relay system, the transmission capacity is twenty-four telephone channels. There are many difficulties in using UHF for long relay system because four or more bearers can not co-exist due to mutual interference of the frequencies being used. When it is forcast that demand in the future will increase largely, although demand at present is small, the selection of whether, initially, a microwave relay system be constructed or a UHF relay system be used and then a microwave relay system be constructed is an important problem which must be determined after careful consideration.

Adequate fundamental carrier terminal equipment has to be prepared initially, that is, carrier supply equipment, supergroup equipment etc., to match the final capacity. Annual demand for circuits is filled with the installation of necessary equipment or panels year after year.

2.3 System Composition

The microwave relay system in each route consists of telephone bearer and stand-by bearer. The same is true on the UHF relay system. Transmission of television signals puts to use the stand-by bearer on the microwave relay system. When the transmission of television programs is increased in the future and the stand-by bearer will be occupied for a long time by television programs, it will be necessary to construct a television bearer independently. This is because it is necessary to be able to use the stand-by bearer in an exchange when the telephone bearer is out of service due to a failure of some sort. The leaking branch method is used in telephone multiplex system to minimize the number of modulations and demodulations and to furnish telephone circuits to Phnom Penh in many cities.

Figure II-3 shows system composition.

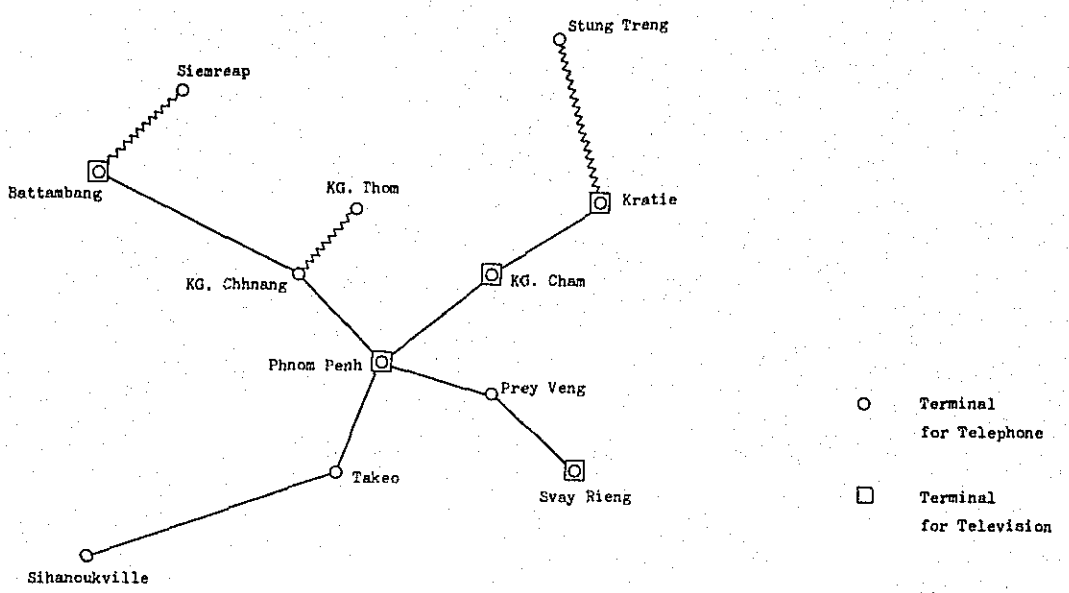


Fig. II-3 System Composition

(1) Phnom Penh ~Battambang

Telephone terminals are installed in Phnom Penh, KG.Chhnang and Battambang. Television terminals are installed in Phnom Penh and Battambang. Television programs through the stand-by bearer can easily be branched everywhere when the necessity arises.

(2) Phnom Penh ~ Sihanoukville

Telephone terminals are installed in Phnom Penh, Takeo and Sihanoukville. Television terminals can be installed in Phnom Penh and Bokor, if necessary.

(3) Phnom Penh ~ KG.Cham ~ Kratie

Telephone and television terminals are installed in Phnom Penh, KG.Cham and Kratie.

(4) Phnom Penh ~ Svay Rieng

Telephone terminals are installed in Phnom Penh, Prey Veng and Svay Rieng. Television terminals can be installed in Phnom Penh and Svay Rieng, if necessary.

(5) Battambang ~ Siemreap

In this section, the UHF relay system is used.

(6) KG.Chhnang ~ KG.Thom

In this section, the UHF relay system is used.

(7) Kratie ~ Stung Treng

In this section, the UHF relay system is used.

3 Selection of Frequency and System to be used

The frequency band used should be that of C.C.I.R. Recommendation 382-1 (2 or 4 GHz band) or that of C.C.I.R. Recommendation 384-1 (6 GHz band), because the transmission capacity is small but sufficient to transmit television signals.

Generally speaking, when comparing some characteristics of the 2 GHz band with those of the 6 GHz band, the characteristics of the 2 GHz band are as follows;

(i) The propagation characteristics are stable.

(ii) Necessary tower height for 2 GHz use is taller than that required for 6 GHz use, because the first Fresnel zone radius in 2 GHz is greater than that in 6 GHz.

(iii) The attenuation by horizontal antenna directivity is not so large.

(iv) Necessary spacing length for antennas becomes larger than that of 6 GHz, when space diversity technique is used.

When the 6 GHz band is used, the abovementioned characteristics show opposite tendencies. If the 4 GHz band is used, the characteristics show intermediate tendencies between the 2 GHz band and the 6 GHz band.

In Cambodia, it may be desirable to use the 2 GHz band, from the view point of the propagation stability, because deep fading occurrence is presumed due to little attenuation of reflected wave and the low altitude of propagation path in many sections. There will be not so much difference, economically, between the 2 GHz band and the 6 GHz band using the same transmission capacity.

When using the 2 GHz band, investigation will be needed on interference that may occur from the trans-horizontal telecommunication network which is used by the armed forces of the United States of America in Vietnam and Thailand.

When using the 2 GHz band, also, it is necessary to be sure that the four frequencies plan is used, because the attenuation of antenna directivity is not sufficient to conform with the noise objective of C.C.I.R. Recommendation 395-1.

For the frequency of UHF relay system, the 400 MHz band is used foreseeing large system gain by the use of parabolic antennas.

Carrier terminal equipment uses frequency-division multiplex. The leaking branch method is especially used for insertion and drop-off of a small number of telephone circuits at intermediate points along the network and to prevent deterioration due to thermal and intermodulation noise.

The use of a PCM system is not considered because the PCM radio system is now under development for the transmission of television signals.

Microwave radio equipment uses frequency modulation and heterodyne repeating system.

UHF radio equipment uses phase modulation and base-band repeating system.

4 Site Selection

4.1 Basic Conditions

Basic conditions to be considered for site selection are as follows;

(i) It is necessary to maintain "line of sight", that is, the first Fresnel zone radius must be secured along the propagation path between adjoining proposed sites. In the "line of sight", the atmosphere refractivity and K, which means the equivalent radius coefficient of the earth, are under consideration. In the tropic zone, it is said that distribution of K is approximately from 4/3 to 3/2. Accordingly, there are no problems on "line of sight", if "line of sight" can be secured under such bad conditions that K equals 4/3.

(ii) Microwave propagation is influenced by the duct type fading which occurs due to irregular variation of the atmosphere refractivity and by K type fading which occurs due to variation of the equivalent radius of the earth.

It is said that the occurrence rate of fading is proportional to frequency to the power of 1.2 and hop distance to the power of 3.6.

Therefore, it is effective to shorten the hop distance or to adopt the space diversity technique when a microwave relay system is planned over the region where fading occurs frequently.

(iii) It is necessary to avoid the selection of too long or too short a hop distance as far as possible and to select the standard hop distance to facilitate balancing between thermal noise and interference noise.

(iv) Bent angle (angle between adjacent paths) or branching angle in the repeater station should be chosen so as not to increase interference noise.

4.2 Route Selection

Maps for preparing profile maps and for route selection are of fifty-thousandth scale or one-hundred-thousandth scale. A fifty-thousandth scale map is sufficiently reliable for field survey purposes. When it was not possible to get a fifty-thousandth scale map, a one-hundred-thousandth scale map is used. However this map is not so reliable in making profile maps.

4.2.1 Phnom Penh ~ Battambang

The microwave network between Phnom Penh and Battambang passes through KG.Chhnang, Krakor and Pursat, because these are the main cities between Phnom Penh and Battambang, and demand for telephone or television will increase there in the future.

Between Phnom Penh and KG.Chhnang, it is necessary to use two hops, for it is too long for one hop. Proposed site is at KG. Luong along the national road or at Batheay on the mountain. When using Batheay, this site can be used for the network between Phnom Penh and KG.Cham, too. In this case, each network between Phnom Penh and Battambang or between Phnom Penh and KG.Cham can make only three both-way bearers, respectively, because the 2 GHz band by C.C.I.R. Recommendation 382-1 can handle only six both-way bearers. Accordingly, it is necessary to use another frequency band between Phnom Penh and Batheay when demand increases.

Between KG. Chhnang and Pursat, it may be possible to use two hops on the mountain-top site. However, three hops along the national road are selected because there are many difficulties and dangers involved in constructing and maintaining the mountain-top repeater station. Proposed site is at Ponley, for long distance between KG. Chhnang and Krakor, and at Krakor.

Between Pursat and Battambang, three hops are planned. Also in this section it seems very difficult to use the mountain-top sites. In selecting sites along the road, there is a plan to select the site at Moung. But three hops have been planned to decrease interruption time due to fading.

4.2.2 Phnom Penh ~ Sihanoukville

Between Phnom Penh and Sihanoukville, it may be possible to select sites along national road No. 4. However, this route can be used only as a direct circuit since there are few villages along national road No. 4. For that reason, the route via Takeo and Bokor is planned.

In this plan no telephone circuits to Kampot are considered. The reason is that it is not on a line of sight route between Kampot and Bokor and that perhaps one more repeater station may be necessary to reach Kampot.

Between Phnom Penh and Takeo, two hops are planned with sites at Chambak or Tram Khhar along the national road.

Between Takeo and Bokor, sites are planned along national road No. 16. Site selection along national road No. 3 has been given up because it is not on line of sight between Bokor and Chhouk due to the ridge on Mt. Bokor. In this section there are many steep and rugged mountains and it seems very difficult to use the mountain-top as a site. Nevertheless, further study to select a convenient site will be required to construct the network economically.

Between Bokor and Sihanoukville, though separation distance is longer than that of standard and a part of propagation path passes over the sea, it is planned to use one hop directly because there is no appropriate alternate site.

4.2.3 Phnom Penh ~ KG. Cham ~ Kratie

Between Phnom Penh and KG. Cham, it is planned to utilize Batheay site, although there is a restriction as mentioned in 4.2.1.

Between KG. Cham and Kratie, there are three microwave route plans. The first plan involves selecting sites along River Mekong. But this plan is not adopted because fading is presumed to occur frequently and there are many difficulties for proper maintenance. The second plan involves selecting sites along national road No. 7. This plan is rejected from an economical point of view, because many hops are needed. Therefore, the third plan is adopted, and proposed sites are at Ph. Sangke Kaong and Chhlong.

4.2.4 Phnom Penh ~ Svay Rieng

The first route plan puts the site at Baphnom. The second plan involves selecting sites at Prey Veng and KG. Trabek. The latter plan is adopted because there is less fading than in the former plan and branching the telephone circuits at Prey Veng is possible.

4.2.5 Battambang ~ Siemreap

It is difficult to construct telephone circuits with good quality by direct relay because, in this section, direct distance is 77 km and propagation path passes over the water. If there are many demands over the UHF relay system, it would be better to construct line-of-sight microwave relay system via Sisophone.

4.2.6 KG.Chhnang ~ KG.Thom

In this section, also, separation distance is long and over the water. Therefore, there is a possibility of many interruptions due to fading, when using a microwave relay system.

4.2.7 Kratie ~ Stung Treng

In this section, sites are installed along the national road due to considerations of maintenance difficulties. If a UHF relay system is used, the circuit can be carried with only two repeater stations. And if a microwave relay system is used, four or five repeater stations will be necessary. Therefore, considering the small demand, a UHF relay system is planned.

4.3 Outline of Proposed Sites

Appendix II shows an outline of the proposed sites and the position on the map.

5 Calculation of Noise Power

5.1 Microwave Relay System

Table II-3 shows the calculation of noise power in comparison with design standards, using the design specifications shown in Table II-4.

Table II-3 Calculation of Noise Power

Section	Distance (km)	Number of Hop	Mean Power in any hour (psophometrically weighted value) (pW)		Probability of Noise Burst Exceeding 1,000,000 pW (%)	
			Objectives	Calculated	Objectives	Calculated
Phnom Penh ~ Battambang	282.5	8	1,047.5	970	0.00113	0.0001 ~ 0.0064
Phnom Penh ~Sihanoukville	231.9	6	895.7	770	0.00112	0.0001 ~ 0.0021
Phnom Penh ~ Kratie	192.6	5	777.8	690	0.00112	0.0002 ~ 0.0027
Phnom Penh ~ Svay Rieng	123.7	3	571.1	570	0.00112	0.0002 ~ 0.006

Table II-4 Design Specification of the 2 GHz Band

Transmission capacity	600 telephone channels or one television
Transmitter output power	32 dBm (1.6W)
Feeder loss	0.06 dB/m
Branching filter loss	2.7 dB/station
Antenna gain (4m ϕ)	35.7 dB
Receiver noise figure	6 dB

5.2 UHF relay System

Table II-5 shows the calculation of noise power using the design specifications shown in Table II-6.

Table II-5 Calculation of Noise Power

Section	Distance (km)	Number of Hop	Calculated Thermal Noise (pW)	Estimated	Circuit Noise
				(pW)	(dB)
Battambang ~ Siemreap	76.7	1	1,310	3,330	54.8
KG.Chhnang ~ KG. Thom	56.0	1	365	2,385	55.4
Kratie ~ Stung Treng	135.7	3	700	7,000	51.5

Note. Circuit noise includes carrier terminal noise of 600 pW.

Table II-6 Design Specification of 400 MHz Band

Transmission capacity	24 telephone channels
Transmission output power	47 dBm (50W)
Feeder loss	0.07 dB/m
Branching filter loss	1 dB/station
Antenna gain (Parobola 4.2m diameter)	20 dB
Receiver noise figure	11 dB
Reciver threshold	- 96.2 dBm
Modulation index	0.4 rad/ch

6 Construction Cost

Table II-7 shows the approximate cost of construction. To construct these nation-wide telecommunication network at one time is a gigantic project. Naturally, construction should be performed in order for the network that takes priority. An example of this order is as follows:

1) Phnom Penh ~ Battambang (Microwave)
2) Battambang ~ Siemreap (UHF)
3) Phnom Penh ~ Sihanoukville (Microwave)
4) Phnom Penh ~ KG. Cham (Microwave)
5) Phnom Penh ~ Svay Rieng (Microwave)
6) KG. Chhnang ~ KG. Thom (UHF)
7) KG. Cham ~ Kratie (Microwave)
8) Kratie ~ Stung Treng (UHF)

Cost for basic network construction contains the cost of the fundamental accommodation; for example, building, access road, tower, power supply and so on. Accordingly, in the next construction these costs are not necessary.

Facilities mean cost for radio equipment, power supply, antenna system, measuring equipment, tower and carrier terminal equipment.

Local charge means cost for ground, building, access road and lead-in of power line.

For reference, cost in the parentheses shows the construction cost when one one-way television bearer, in addition to the two both-way bearer, is constructed independently from Phnom Penh in the down-direction.

Table II-7 Construction Cost

Unit: Thousand Riel (6.5 Riel = ¥1)

Section		Local charge	Facilities	Total	TV
Phnom Penh ~ Battambang	Microwave	10,000	106,000	116,000	(6,500)
Battambang ~ Siemreap	UHF	1,100	7,900	9,000	-
Phnom Penh ~ Sihanoukville	Microwave	4,200	70,000	74,200	(4,000)
Phnom Penh ~ KG. Cham	Microwave	800	29,000	29,800	(1,600)
Phnom Penh ~ Svay Rieng	Microwave	2,300	38,000	40,300	(2,500)
KG. Chhnang ~ KG. Thom	UHF	1,100	7,500	8,600	-
KG. Cham ~ Kratie	Microwave	4,200	33,400	37,600	(2,500)
Kratie ~ Stung Treng	UHF	2,000	21,300	23,300	-
Total		25,700	313,100	338,800	(17,100)

7 Future Problems

The above-mentioned plan is an example of the nation-wide radio relay system in Cambodia, based on the outcome of the first survey carried out by THE JAPAN TELECOMMUNICATIONS AND BROADCASTING SURVEY TEAM TO CAMBODIA.

This plan is still open to discussion on the details because the survey team did not have sufficient time to perform a thorough field survey.

At present, the following problems will have great influence on the final system design.

(i) Necessary tower height is determined by the necessity of securing the first Fresnel zone radius and a margin for tree height (from five to twenty meters) at the midpoint of the propagation path, on a profile map using K=4/3 that is drawn up from a fifty-thousandth scale or one-hundred-thousandth scale map.

Mirror tests can not be performed easily when both adjoining sites are on plain ground and there are high trees around the sites.

Therefore, the tower height cannot help being determined on the basis of the accuracy of map used and estimated tree height. Line of sight is indispensable when constructing a microwave relay system. Accordingly, it is desirable to apply mirror test for each hop.

(ii) In many propagation paths, deep fading will be presumed to occur frequently since the attenuation of reflected wave is small, because reflecting point of radio wave is on the water surface or the rice-field surface and there are no obstacles on the path of reflected wave, and since the path of direct wave is at low altitude.

In theory, the receiving power at a site decreases approximately to zero in the worst case when the receiving power of reflected wave is nearly equal to that of the direct wave. Quantitative evaluation is needed to confirm how much the reflected wave attenuation and the fading occurrence actually are.

The variation of atmosphere refractivity has an important influence on the propagation through low altitude.

For these reasons, it will be necessary to make propagation tests at a few representative paths in order to estimate the propagation stability.

III TELEVISION BROADCASTING NETWORK

1 Establishment of New TV Broadcasting Stations

1.1 Selection of New TV Broadcasting Stations Sites

If the whole area of Cambodia is to be served by a TV broadcasting network, a considerably large number of TV stations will have to be installed and a huge amount of construction cost will be required.

The area in the vicinity of the border line has a sparse population in general and, as a result, the effect of increasing coverage of population compared with required construction cost is very low. Therefore, the construction of TV broadcasting stations in this area is not advisable. For this reason, it will be necessary under the current project to exclude these sparsely populated areas from its scope and select the TV station sites with the aim of providing an adequate television service for densely populated areas.

After making a thorough study on the population distribution, topography and electric power situation in Cambodia, the Japanese Survey Team picked Battambang, Kompong Thom, Bokor, Svay Rieng, Kompong Cham, Kratie, Pursat and Siemreap, a total of eight regions, as the proposed sites for stations from the standpoint of economy and network efficiency.

1.2 Service Area and Coverage

Estimated service areas to be covered by the above eight prospective stations and the existing station in Phnom Penh, obtained from claculation, are shown in Fig. III-1. Reference to this figure, all of Sihanoukville, Kampot and Kep, major cities to be covered by the station in Bokor, are out of line-of-sight from the top of the mountain in Bokor. As a result, there is uncertainty as to whether these areas could be covered by the station with satisfactory picture quality.

The result of a simple propagation test conducted by this team shows that there is a prospect of obtaining almost satisfactory field strength in Sihanoukville and Kampot.

The population and coverage within the service area of the nine stations, including the Phnom Penh station, are shown in Table III-1. From this table, the population within the fairly visible area upon completion of the nation-wide TV network is estimated at 6.2 million, or coverage of about 95% of the total population of Cambodia.

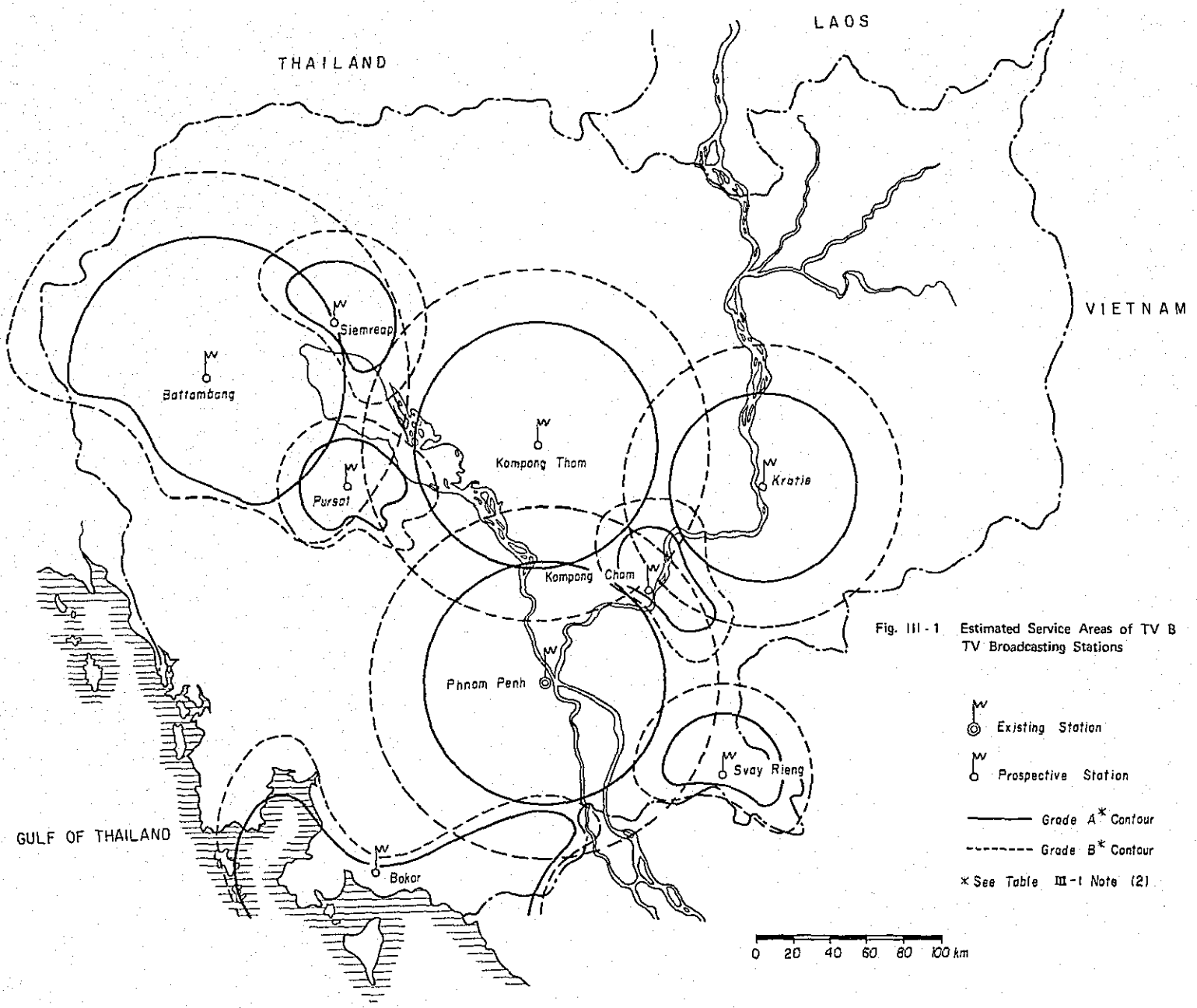


Fig. III - 1 Estimated Service Areas of TV B TV Broadcasting Stations

Table III-1 Population and Coverage in the Service Areas of TV Broadcasting Stations

Location	Population (Thousand)			Coverage (%)	Remarks
	Grade A	Grade B	Total		
Phnom Penh	2,564	432	2,996	45.9	Existing
Battambang	651	185	836	12.8	Prospective
Kompong Thom	459	89	548	8.4	do.
Bokor	426	57	483	7.4	do.
Svay Rieng	393	77	470	7.2	do.
Kompong Cham	295	84	379	5.8	do.
Kratie	160	88	248	3.8	do.
Pursat	125	6	131	2.0	do.
Siemreap	106	6	111	1.7	do.
Total	5,178	1,024	6,202	95.0	

Note: (1) Total population of Cambocia is about 6,527,800 (on the authority of 1968 statistical data).

(2) Grade A: Within the field intensity contour of 55 dbμ relative to 1 μV/m, where television service of fine picture quality will be provided.

Grade B: Within the field intensity contour of 45 dBμ where TV service of fair picture quality will be provided.

1.3 Specifications of Prospective TV Stations and Transmitter Sites

Specifications of TV stations at each proposed site are shown in Table III-2. For the transmitting site of each station, it will be advantageous to utilize high ground for service to large areas, but the use of high ground involves the following problems:

(1) Unfavorable access road condition and power supply situation.
(2) Inconvenience involved in maintenance of station facilities.
(3) Increased construction cost for studio facilities in the future.
(4) The extensive ground required for installation of the station is adequately available within the city area or in its outskirts.

For these reasons, it will be more advantageous economically to avoid the construction of the station at the top of a mountain, and to select an appropriate site within the city area for construction of a high transmitting antenna mast. For the Bokor area, however, because its location is in a mountain area 1,000 meters above sea level, it will not be necessary to construct a very high transmitting antenna.

Table III-2 Specifications of Transmitting Stations for Prospective Plan

Station	Channel (Offset)	Frequency Vision/Sound MHz	Transmitter power Vision/Sound kW	Antenna system			Max. ERP Vision kW	Antenna altitude above sea level m	Antenna support
				Type*	Gain dB	HRP**			
Battambang	10	193.25/197.75	10 / 2	12-ST	10	ND	100	110	100-m Stayed mast
Kompong Thom	11	199,25/203.75	5 / 1	12-ST	10	ND	50	120	do.
Bokor	10(+)	193.26/197.76	1 / 0.2	3-2D-2	10	D	10	1,100	30-m Tower
Svay Rieng	12	205.25/209.75	0.5 / 0.1	4-2D-3	10	D	5	105	100-m Stayed mast
Kompong Cham	13	211.25/215.75	0.1 / 0.02	3-2D-2	10	D	1	120	do.
Kratie	7	175.25/179.75	1 / 0.2	12-ST	10	ND	10	120	do.
Pursat	9	187.25/191.75	0.1 / 0.02	2-2D-3 4-2D-1	10	D	10	120	do.
Siemreap	8(+)	181.26/185.76	0.1 / 0.02	4-2D-3	10	D	1	120	do.

* 12-ST : 12-stacked superturnstile antenna

3-2D-2 : 3-stacked 2-Dipole panels on 2 faces of an antenna support

** HRP : Horizontal Radiation Pattern

D : Dirctional

ND : Non-Directional

2 TV Standard and Frequency Allocations

2.1 TV Standard

The television standard now in use in Cambodia is system M in C.C.I.R. Report 308 (Geneva, 1963), and the frequency is the FCC channels in Band III.

For the television standard presently used in Southeast Asia countries, system B of C.C.I.R. is widely used by many countries and system M is being used by a very few countries. In order to realize smooth exchange of TV programs between different countries, television system standardization to the greatest extent possible is important. It will be necessary, therefore, for Cambodia to give due consideration to this question and make necessary studies over a long period of time, when the nation-wide TV network expansion project is being formulated.

In working out the plan, the survey team decided to adopt system M, which is presently in use in Cambodia, as the standard and Band III for frequency, upon full consultations with staff personnel of the Ministère de l'Information and by taking into account the following factors:

(1) The neighboring country, Thailand, has already decided to adopt system B for its TV standard. In view of many mountainous areas on the border line between Cambodia and Thailand, the strength of interfering signal coming from Thailand is not considered great.

(2) In another neighbor country, Vietnam, the US Forces are now providing television services using FCC channels of system M. In the area of a relatively dense population in the southeastern region of Cambodia, where flat terrain is dominant in the vicinity of the border line between Cambodia and Vietnam, the interfering television signal levels from Vietnam are quite high. As a result, the number of channels available to Cambodia will inevitably become fewer. If both countries are to use television standards differing from each other, the impact will be far greater and the number of channels available to Cambodia will become far smaller, thus causing major obstacles to the establishment of the intended network.

Table III-3 shows characteristics of system B and system M, based on C.C.I.R. Report 308-1 (Oslo, 1966).

Table III-3 Characteristics of Monochrome Television System

(Based on C.C.I.R. Report 308-1)

Item	Characteristics	System	
		M	B
	Video charactreistics		
1	Number of lines per picture (frame)	525	625
2	Field frequency (fields/second)	60	50
3	Interface	2/1	2/1
4	Pricture(frame) frequency (pictures/second)	30	25
5	Linc-frequency and tolerance when operated one-synchronously (lines/second)	15 750	15 625±0.1%
6	Aspect ratio (width/height)	4/3	4/3
7	Scanning sequence . . . . . (Line) (Field)	Left to right Top to bottom	Left to right Top to bottom
8	System capable of operating independently of power supply frequency	Yes	Yes
9	Approximate gamma of picture signal . . .	0.45	0.5
10	Nominal video bandwidth (MHz)	4.2	5
	Radio-frequency characteristics		
11	Nominal radio-frequency bandwidth (MHz)	6	7
12	Sound carrier relative to vision carrier (MHz)	+4·5	+5·5
13	Sound carrier relative to nearest edge of channel (MHz)	-0·25	-0·25
14	Nominal width of main sideband (MHz) (ν) .	4·2	5
15	Nominal width of vestigial sideband (MHz) (MHz) (ω)	0·75	0·75
16	Type and polarity of vision modulation . . .	ASC negative	ASC negative
17	Synchronizing level as a percentage of peak carrier	100	100
18	Blanking level as a percentage of peak carrier peak carrier	72·5-77·5	72·5-77·5
19	Difference between black level and blanking level as a percentage of peak carrier . . .	2·875-6·75	0-7
20	Peak white level as a percentage of peak carrier	10-15	10-12·5
21	Type of sound modulation	F3, ±25 kHz 75 μs pre-emphasis	F3, ±50 kHz 50 μs pre-emphasis
22	Radio of effective radient powers of vision and sount (')	10/1-5/1	5/1-10/1 *

* 4/1; For the Japanese 525-line system
2/1; In Cambodia

2.2 Channel Allocation Plan

The frequency in use for TV service varies greatly with each country and the same TV standard does not necessarily require the same frequency. Shown below are the frequency for broadcasting service allocated to region 3 (Asia) in accordance with provisions of the International Radio Regulations.

Table III-4 Frequencies for Television Broadcasting Service in Region 3 (Asia)

Frequency range MHz	Band designation
44 - 50 & 54 - 68	Band I (VHF)
87 - 108	Band II (VHF)
170 - 216	Band III (VHF)
470 - 585	Band IV (UHF)
610 - 960	Band V (UHF)

Use of Band III only in Cambodia at present is due to the following reasons.

(1) Band I requires a large transmitting and receiving antenna with resultant high cost. It is often subject to greater effects of reflected signals from the sporadic E layer and is also susceptible to city noise.

(2) Band II may be used only for 3 TV channels and is being used for FM in many countries. As a matter of fact, this band is being used in Cambodia for relaying radio programs between Phnom Penh and Kep on 94 MHz.

(3) Band III is used solely for TV broadcasting in every country and a large number of channels are available from this band.

(4) It is desirable, under the present circumstances, to limit the use of Band IV/V to the relay of TV program and to contemplate the use of this band for broadcasting only when VHF channels are unavailable in the future.

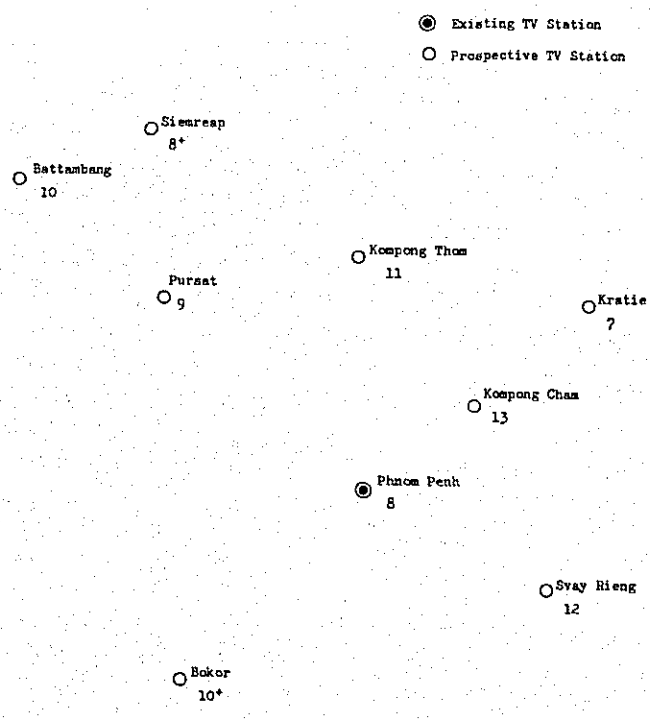
Though there are various ways to arrange TV channels in Band III, adoption of system M will make it inevitable to use the FCC channels in view of the relation of the channel presently used by Phnom Penh station with Vietnam. Table III-5 shows the FCC channels and the C.C.I.R. channels of system B in Band III.

Table III-5 Numerical Designation of Television Channels in Band III

American (FCC)525-line system (C.C.I.R. system M)			European 625-line system (C.C.I.R. system B)	
Channel No.	Frequency band MHz	Carrier frequency Vision/Sound MHz	Channel No.	Frequency band MHz
7	174 - 180	175.25 / 179.75	5	174 - 181
8	180 - 186	181.25 / 185.75	6	181 - 188
9	186 - 192	187.25 / 191.75	7	188 - 195
10	192 - 198	193.25 / 197.75	8	195 - 202
11	198 - 204	199.25 / 203.75	9	202 - 209
12	204 - 210	205.25 / 209.75	10	209 - 216
13	210 - 216	211.25 / 215.75		

One of the channel allocation plans for the nation-wide TV network worked out by the survey team, with considerations given to the channels presently in use in Vietnam, is shown in Fig. III-2.

Fig. III-2 Channel Allocations.



Note: Plus(+) symbol after channel No. designates offset carrier position.

Frequency channels for UHF relay stations to be established for relaying TV program may be allocated from Band IV/V.

3 TV Program Relay System

3.1 Outline

The microwave relay system and the rebroadcast system are available as methods of relaying a TV program to newly established stations.

With the microwave relay system, the vision and sound signals are transmitted by microwave network to be established by M.P.T. This method is considered best for the transmission of high quality signals.

With the rebroadcast system, the program (VHF) from the parent TV station is received directly and retransmitted after the frequency of signals has been converted.

When direct reception by radio of a program from the parent station is not possible, a UHF relay station (UHF Translator) must be installed between the rebroadcast station and the parent station. This relay system is not so advantageous as the microwave relay system for transmission of high quality signals. Therefore, the use of the system is not desirable when many relay stations are linked in series. However, when there are less relay stations involved, and as long as the design of each relay station provides adequately received field strength, this system will not cause any problem in practical use.

From the standpoint of construction cost, meanwhile, the microwave relay system is not so advantageous as the rebroadcast system. However, when the microwave network is constructed for the dual purpose of handling both TV program relay and expanding telephone circuit, the cost of this system as the TV relay network is considered reasonable and it may become equally or more economical than the rebroadcast system.

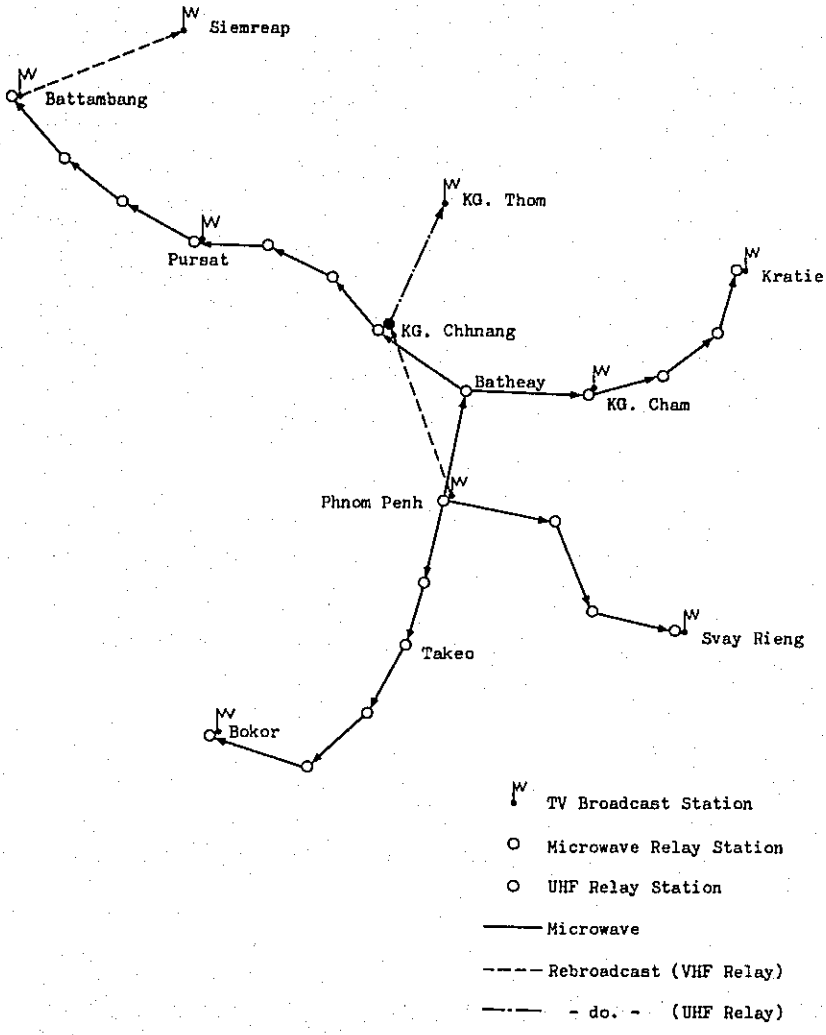
In the case of a rebroadcast station without requiring a UHF relay station between its location and the parent station (for instance, the station in Bokor relaying the program by direct reception of radio from the Phnom Penh TV station), the deterioration of characteristics of this system will be far less and the rebroadcast system may become the most advantageous means from an economical point of view.

3.2 Microwave Relay System

As part of the Telecommunication Network Expansion Project of M.P.T., a microwave network project is being formulated for four routes, namely, from Phnom Penh to Battambang, Stung Treng, Sihanoukville and Svay Rieng. The Japanese Survey Team on the basis of the result of technical surveys under this project, considers the network as shown in Fig. II-1.

If all the routes of this microwave network are to be used solely for TV program relay, the future TV network will be as shown in Fig. III-3. Because of technical difficulties involved in the use of microwave route between Battambang and Siemreap, this figure shows the use of a rebroadcast system. For the section between Kompong Chhnang and Kompong Thom, whose propagation path is over the water and, therefore, the use of microwave relay involves a considerable difficulty, the rebroadcast system with the utilization of UHF relay station has been adopted.

Fig. III-3 The Television Network Linked with Microwave Relay System.



3.3 Rebroadcast System

If a TV program relay network has to relay solely on the microwave network of M.P.T., its realization will inevitably restrict the timing of construction of TV network Expansion Project. If the expansion of the network is to be contemplated without being influenced by the timing of construction of the microwave network, the TV relay network must be established by the Ministère de l'Information only. In this case, it is advisable to adopt the rebroadcast system in view of its economical advantages.

Figure III-4 shows an example of a network using this system. Denotation of "VHF relay" in this figure indicates relaying programs transmitted from the parent station by VHF to a succeeding station and that of UHF relay indicates relaying programs transmitted from the parent station or from the parent relay station by UHF relay to a succeeding station. The figure also shows the requirement for a total of six UHF relay stations. Outline of required facilities of these UHF relay stations is given below.

Table III-6 Outline of UHF Relay Station Facilities

(1)	Transmitter type	Translator
(2)	Transmitter output power	100 W
(3)	Height of the antenna	Transmitting: 100 m Receiving : 100 m
(4)	Type of transmitting antenna	4-m diameter grid parabolic antenna
(5)	Type of receiving antenna	4-m diameter grid parabolic antenna or 8-10 elements YAGI antenna
(6)	Building (floor space)	Approx. 50 m^2
(7)	Generating set	10 KVA Diesel-electric set (at Krakor and Svay Daun Keo)

Fig. III-4 The Television Network Linked with Rebroadcast System.

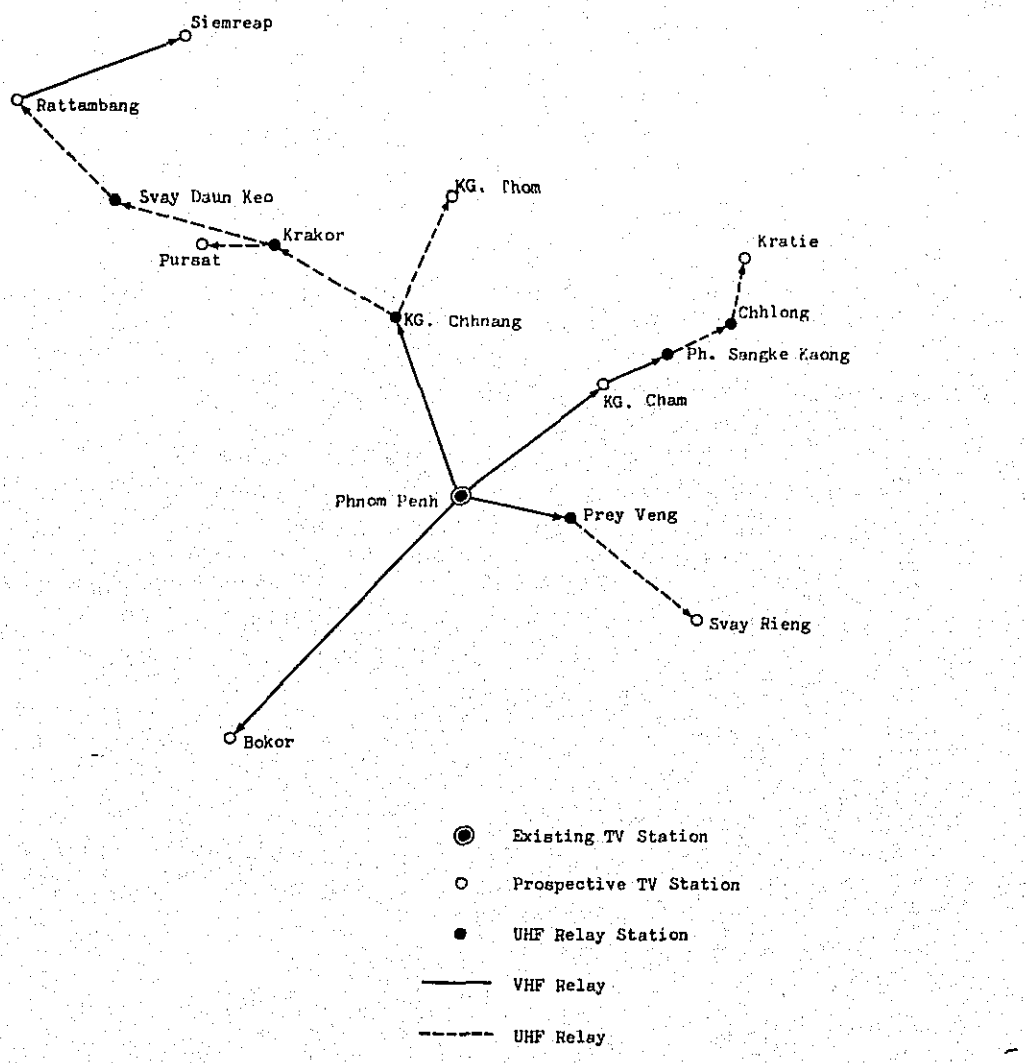
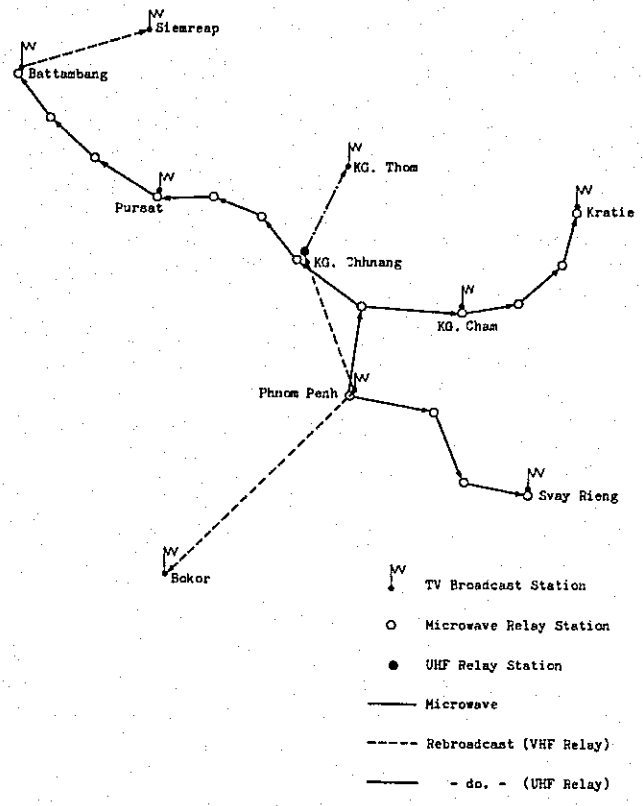


Fig. III-5 The Television Network Linked with Microwave and Rebroadcast Combined System.



3.4 Application System

TV program relay network may be constructed economically by properly combining the microwave relay system with the rebroadcast system. An example of the above combination system is shown in Fig. III-5. Basis for the selection of relay system for each route are as follows.

(1) Phnom Penh - Pursat - Battambang

Since the microwave circuit for this route is designed to provide relay of the TV program also, there is no need to consider the adoption of a rebroadcast system.

(2) Battambang - Siemreap

For this route, the use of microwave relay system is technically impossible and it would require a great deal of investment if a microwave route were planned. Therefore, it is advisable to adopt the rebroadcast system for relay of TV programs on this route.

This route covers about 75 km and, if a proper selection of receiving facilities is made at Siemreap, relaying the television program for practical use is considered possible. However, the propagation path of this route is expected to be inundated during the rainy season and there is a possibility of fading occurrence. As the construction of the Siemreap station is expected to begin after a considerable lapse of time following the completion of the Battambang station, it is advisable to make a full study of the influence of fading during construction before the selection of a relay system is made.

(3) Phnom Penh - Kompong Thom

If a microwave relay system is to be used for this route, the relay will be made by a branch circuit from Kompong Chhnang. If the rebroadcast system is to be used, the program from Phnom Penh will be received at Kompong Chhnang and relayed to Kompong Thom by UHF relay circuit. As both systems require almost the same amount of investment, it is advisable to make the selection of a relay system for this route in conjunction with the Telephone circuit expansion project of M.P.T.

If the telephone circuit is to utilize microwave, the relay of TV programs should be contemplated at the same time. If UHF is to be used for the telephone circuit, the relay of TV programs should be by means of rebroadcast system.

(4) Phnom Penh - Kompong Cham - Kratie

For this route, it is advisable to use a microwave relay system for the relay of TV programs for the following reasons.

a) Although rebroadcast for the Phnom Penh - Kompong Cham route is considered possible, lack of stability in the rebroadcast must be expected because of fading.

b) If the rebroadcast system is to be used for the Kompong Cham-Kratie route, two UHF relay stations will be required, the same number required by the microwave relay system.

c) From the economical point of view, there is not a wide difference between the case in which the rebroadcast system is used up to Kompong Cham and the microwave relay system is used for the Kompong Cham - Kratie route and the case in which the microwave relay system is used for the entire route between Phnom Penh and Kratie.

d) Unless greater economical advantages are derived from other means, it is advisable to adopt the microwave relay system to maintain high transmission signal quality.

(5) Phnom Penh - Bokor

There is a strong likelihood for satisfactory reception of TV signals from Phnom Penh at the top of Bokor mountain. The measured field strength value for vision was 66 dBμ. This value is inconsistent with the result of a calculation by a profile map. As this field strength is sufficient if the problem of fading and ghost image is not involved, the use of the rebroadcast system which requires no intermediate UHF relay station will be more advantageous for this route than the use of the microwave relay system.

(6) Phnom Penh - Svay Rieng

If the rebroadcast relay system is to be used for this route, a UHF relay station must be located in Prey Veng. For this reason, it is extremely difficult to discriminate between this system and a microwave relay system in terms of the construction cost. Consequently, the relay system selection must be made in conjunction with the Microwave Network Project of M.P.T.

In this report, the microwave relay system has been adopted on the assumption that the microwave route will be completed before the completion of the Svay Rieng TV station.

4 Construction Cost of Nation-wide TV Network Expansion Project

Construction cost required for the Nation-wide TV Network Expansion Project, is shown by estimate in Table III-7. In this table, the cost of facilities also includes the cost of the antenna mast. Local charge includes the construction cost of station building and roads and the cost of power supply line.

Table III-7 Construction Cost

(Unit ; 1,000 Riel)

Station	Relay system					
	Microwave		Rebroadcast		Combined	
	Facilities	*Local charge*	*Facilities*	*Local charge*	*Facilities*	*Local charge*
TV station						
Battambang	17,500	3,500	17,000	3,500	17,500	3,500
Kompong Thom	15,000	3,500	15,000	3,500	15,000	3,500
Bokor	7,000	3,000	6,500	3,000	6,500	3,000
Svay Rieng	10,000	2,000	9,500	2,000	10,000	2,000
Kompong Cham	7,500	1,500	7,000	1,500	7,500	1,500
Kratie	11,500	3,000	11,000	3,000	11,500	3,000
Pursat	8,000	1,500	7,500	1,500	8,000	1,500
Siemreap	7,500	1,500	7,500	1,500	7,500	1,500
Total	84,000	19,500	81,000	19,500	83,500	19,500
UHF relay station						
Kompong Chhnang	6,500	1,500	6,500	1,500	6,500	1,500
Krakor	-	-	7,000	1,500	-	-
Svay Daun Keo	-	-	6,500	1,500	-	-
Ph. Sangke Kaong Est.	-	-	6,500	1,500	-	-
Chhlong	-	-	6,500	1,500	-	-
Prey Veng	-	-	6,500	1,500	-	-
Total	6,500	1,500	39,500	9,000	6,500	1,500
Grand total	90,500	21,000	120,500	28,500	90,000	21,000

5 Expansion of Studio Facilities

Ministere de l'Information now is contemplating provision of an additional studio at the Phnom Penh Station and a new TV studio at Battambang, Kompong Cham and Sihanoukvill, respectively. A request was made to this survey team fro the formulation of a studio expansion project. It is needless to say that the studio expansion is necessary for the expansion of TV programs and for the improvement of the program quality. However, the formulation of the project must be made carefully by giving full consideration to its relations with the program expansion plan, personnel plan and financial plan. Since no data on these plans are available, it is extremely difficult for the team to formulate a satisfactory studio expansion project. As a result, only a rough estimate of the cost required for the minimum expansion of studio facilities has been made as shown in Table III-8. This cost is only for the equipment and, therefore, does not include the cost of local purchase items such as buildings etc.

Table III-8 Estimated Cost for the Expansion of Studio Facilities

(Unit: 1,000 Riel)

Equipment	Center station	Local station
Studio equipment	9,000	7,000
Master control equipment	5,500	3,500
Telecine equipment	-	5,500
Other equipment	3,000	3,000
Total	17,500	19,000

6 Future Problems

6.1 Rebroadcast Relay

When the TV program is relayed by the rebroadcast system, fading will be the most serious problem. In Cambodia, the majority of radio wave propagation paths are over flat spherical ground surface which often turns to impounded water during the rainy season. This brings about an extreme disadvantage in the occurrence of fading. It is advisable, therefore, to make reception tests for every route, if possible, for which the rebroadcast system is contemplated. Particularly for the Phnom Penh - Bokor route having a long propagation path, a fairly strong fading is expected. To determine whether the anticipated fading will pose any problems in using this route for relaying TV program, reception test must be made over the longest period possible of time. As the condition of the propagation path is not favorable for the Phnom Penh - KG.Chhnang route, either, it is advisable to make reception tests over a long period of time at KG.Chhnang if the rebroadcast system is to be adopted for KG. Thom.

6.2 Service Area

The limit of service area may be estimated for most of the stations through calculation. For the Bokor station, however, it's major service areas of Kampot, Kep and Sihanoukville are all out of the line-of-sight. Therefore, the determination of service area by relying on calculation alone runs a risk. This

is because the area out of the line-of-sight is often subject to ghost image and, therefore, the ghost test must be conducted along with the propagation test to determine actual condition in advance.

6.3. Other Requirements

For the preparation of the project, there will be a need for further studies on the following items.

(1) TV station operating pattern (attended station or unattended station)

(2) Auxiliary facilities (spare broadcasting equipment, emergency power generator)

(3) Preference in the order of construction of stations. (for example, top priority is to be given to the Bokor and Battambang stations and construction of other stations is to be coordinated with the progress of construction of microwave relay system. However, the Pursat and Siemreap stations are to be constructed at the final phase of the project.)

IV RADIO BROADCASTING NETWORK

1. Present Service Area

In Cambodia, radio broadcasting on medium waves is being made with a total of four radio channels, two at the Phnom Penh station, one at the Battambang station and one at the Kep station. However, as it is almost impossible for these stations to cover the whole country, two short wave channels are being used at the Phnom Penh station to broadcast identical programs. On the other hand, in view of the fact that the radio receiving set most widely used throughout the country is for medium wave, expansion of service area through medium wave broadcasting is most advisable.

As the survey team had not carried a short wave and medium wave field intensity meter during this survey, measurement of field strength of each broadcast frequency in Cambodia was not possible.

For this reason, the estimate on the field strength was based on the C.C.I.R. Recommendation No. 368, 11th Plenary Assembly (OSLO, 1966) and the data available in Japan. Service area of each station obtained through computation is shown in Fig. IV-1. Service area standards are shown in Table IV-1. Figures shown in Table IV-1 are based on the figures used in Japan. In applying these figures to Cambodia, a value almost identical to that used in Japan was adopted in view of the fact that the effect of man-made noise is great in Japan, whereas the effect of tropical atmospheric noise is greater in Cambodia.

Table IV-1 Standard of Service Areaa

	Field Intensity (mV/m)
Large city	above 10
Medium city	above 5
Small city	above 1
The others	above 0.5

Table IV-2 Existing Coverage

Station name	Population in the service area (thousand)	Coverage of total population (%)
Phnom Penh	4,885	75
Battambang	269	4
Kep	162	2
Total	5,194 *	80 *

* As the service area of Kep station overlaps the service area of Phnom Penh station, the total value shows the value from which the overlapped population is deducted.

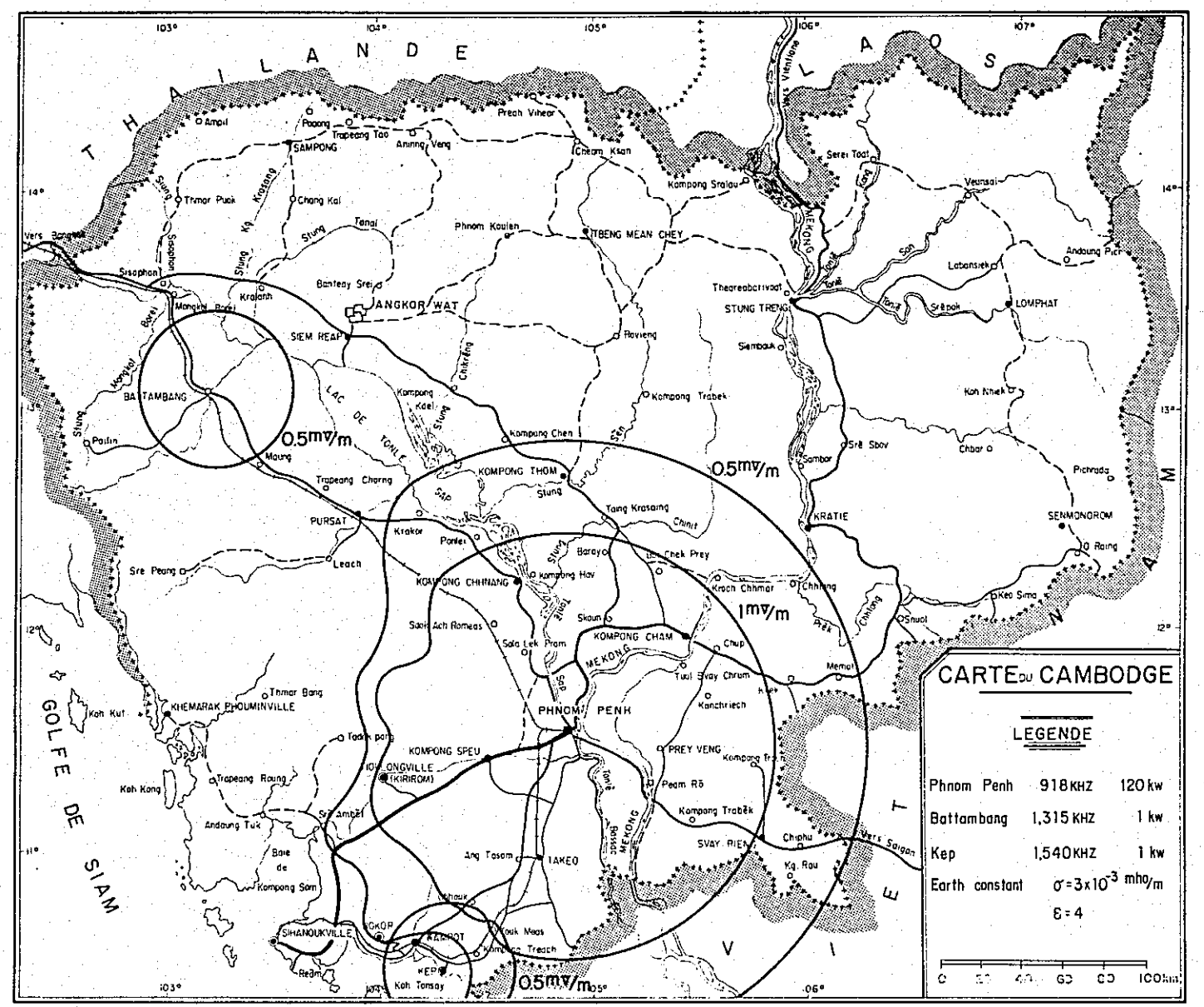


Fig. IV - 1 Existing Service Areas

It will be appropriate to determine the service area by applying the standard of "Large city" to Phnom Penh, " Small city" to provincial capitals and "Others" to the remaining areas. According to this standard, in Kompong Thom and Kampot, there is a field strength of more than 0.5 mV/m, but it is insufficient for the standard value which would allow receiving the broadcast with satisfactory quality. Kep, Kratie and Pursat are excluded from the service area of the Phnom Penh station. (However, Kep and Kampot are within the service area of the Kep station). The field strength in Siemreap is not sufficient, either, to receive a satisfactory quality broadcast from the Battambang station. A good example of the difficult in reception is the occasion when a night reception was attempted by the survey team at Kratie, but the broadcast from the Phnom Penh station was not heard at all.

The population within the service area of all stations is estimated at about 5.2 million or about 80% of the total population. The figure of 80% seems to represent a fairly high coverage, but there still remain some problems to be resolved.

2 Improvement Expansion of Service Area

Though the present coverage by medium wave broadcasting has such a high figure as 80 %, expansion of this coverage to close to 100% will require intensive studies on the following items in view of the density of population and the importance of the city involved.

(1) Improvement of service for Kompong Thom
(2) Intensification of broadcasting for Siemreap, Sihanoukville, Pursat, Kratie and Stung Treng

To achieve the above objectives, the following detailed measures will have to be put into practice.

(1) Reexamination of specific character of existing facilities

   a. Matching between transmitters and antenna

   b. Improvement of antenna efficiency

(2) Establishment of stations and increase of transmitting power

During the observation of facilities by the survey team, it was not certain whether the transmitter output was efficiently emitted through feeder and to antenna, judging from the readings of watt meters installed on some of the transmitters and the height of antenna. There must be a precise measurement of the transmitting system and the improvement must be contemplated on the basis of the result of such measurement to increase effective radiation power.

Besides, the increase of transmitting power at the Phnom Penh and Battambang stations and the establishment of stations at Sihanoukville, Stung Treng and Rattanakiri should be contemplated for expansion of service area.

3 Project Formulated by Cambodia

According to the project already approved by Ministère de l'Information, increase of transmitting power at the Phnom Penh and Battambang stations (Phnom Penh's 818 kc, 120 kW transmitter is to remain the same, but the 740 kc, 20 kW is to be increased to 200 kW and Battambang's 1 kW transmitter is to be increased to 10 kW) and the inauguration of the Kratie station (1 kW) are to be realized within the year. Estimated service area upon completion of the above project is shown in Fig. IV-2. The population within the service area is estimated at 5.7million, or a coverage of about 87% of the total population, as shown in Table IV-3.

Table IV-3 Coverage at the end of 1970

Station name	Population in the service area (thousand)	Coverage of total population (%)
Phnom Penh	5,386	83
Battambang	304	5
Kep	162	2
Kratie	90	1
Total	5,690*	87*

* As the service area of Kep station and that of Kratie station overlaps the service area of Phnom Penh station, the total value shows the value from which the overlapped population is deducted.

It is evident from Fig. IV-2 that the service area of the newly established Kratie station is included in the service area of the Phnom Penh station and that Siemreap, Stung Treng and Sihanoukville are still outside of the service area. For Sihanoukville and Stung Treng, there is a plan for the establishment of stations in the future and antenna improvement is being planned for the Battambang station.

4 Future Problems

In view of the important role of broadcasting in providing information, entertainment and education for the public, the broadcasting service must be further expanded.

As the first step, an accurate evaluation of the present service area will be most important. This will be done during the next survey and, therefore, it is hoped that the result of such survey is used as the basis for more detailed studies on the future broadcasting expansion project.

Relay of programs from the Phnom Penh station to local stations should utilize microwave network following its completion instead of the present VHF or short wave relay in order to obtain a good quality broadcast.

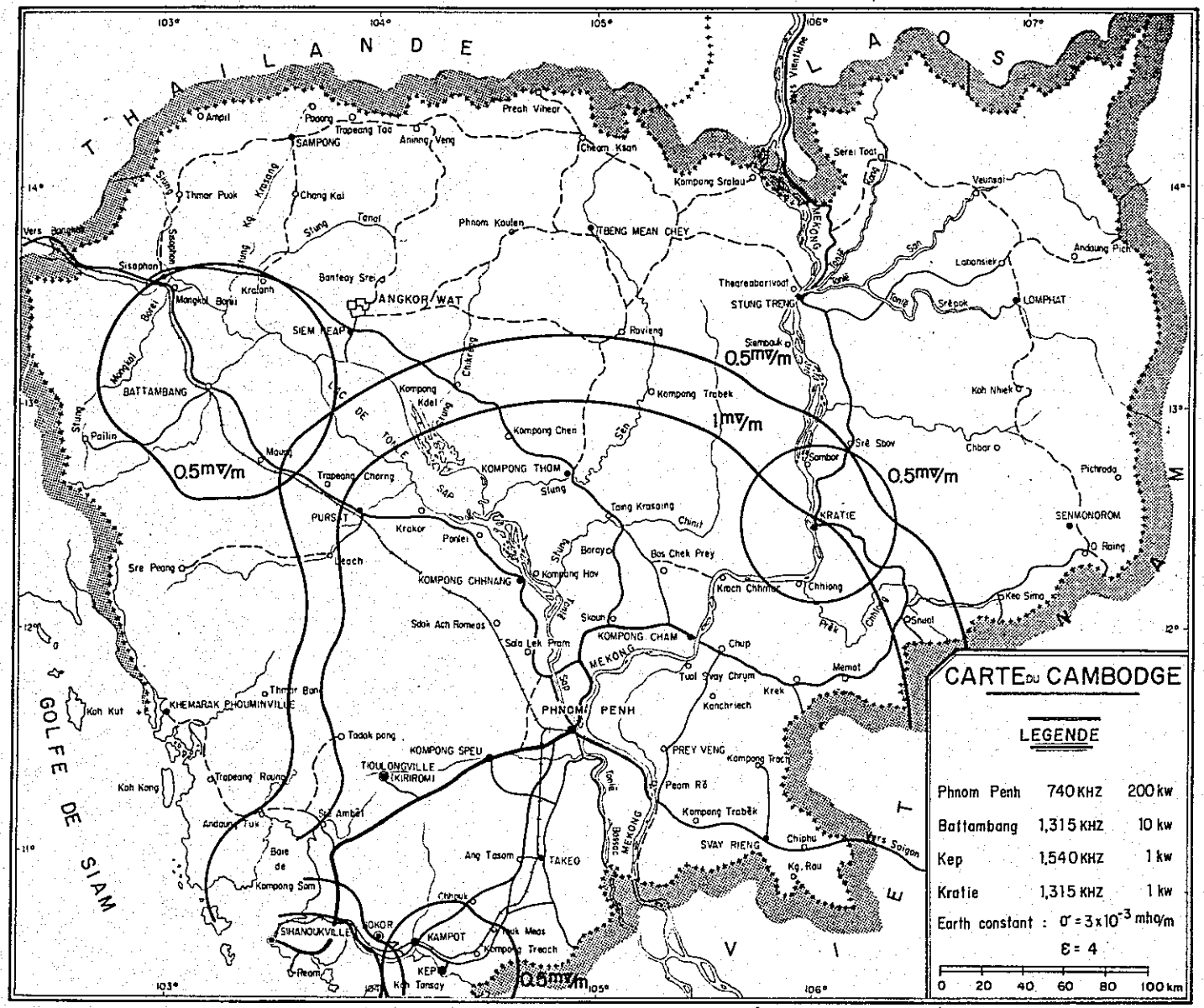


Fig. IV - 2 Service Areas at the End of 1970

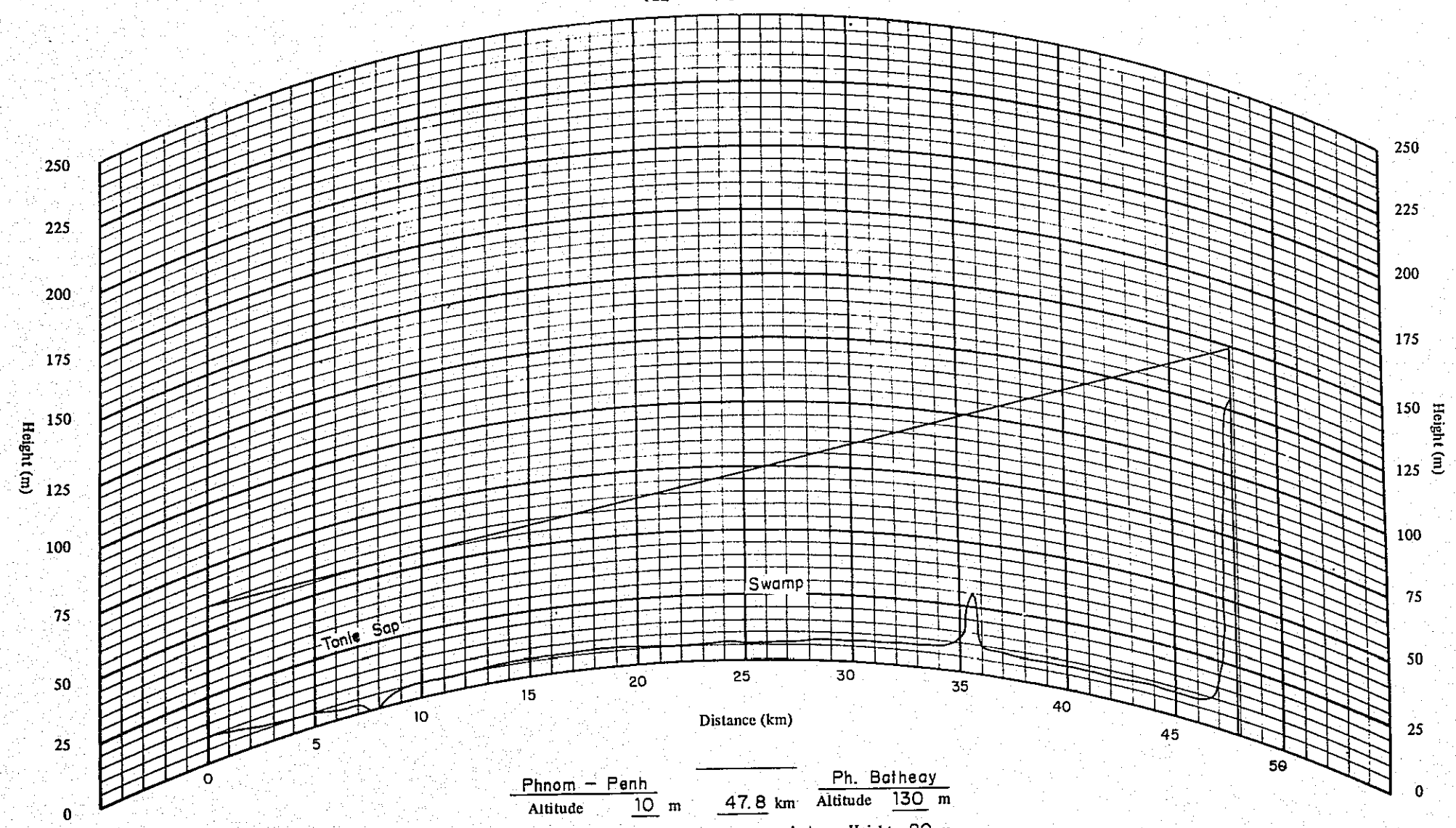
APPENDIX

APPENDIX I PROFILE MAP

1.	Phnom Penh	~	Phnom Batheay
2.	Phnom Batheay	~	KG.Chhnang
3.	KG.Chhnang	~	Ponley
4.	Ponley	~	Krakor
5.	Krakor	~	Pursat
6.	Pursat	~	Svay Daun Keo
7.	Svay Daun Keo	~	Stoeng Chak
8.	Stoeng Chak	~	Battambang
9.	Battambang	~	Siemreap
10.	KG.Chhnang	~	KG.Thom
11.	Phnom Penh	~	Tram Khnar
12.	Tram Khnar	~	Takeo
13.	Takeo	~	Kbal Bat
14.	Kbal Bat	~	Chamkar
15.	Chamkar	~	Bokor
16.	Bokor	~	Sihanoukville
17.	Phnom Batheay	~	KG.Cham
18.	KG.Cham	~	Sangke Kaong
19.	Sangke Kaong	~	Chhlong
20.	Chhlong	~	Kratie
21.	Kratie	~	Sre Sbov
22.	Sre Sbov	~	Ph.Nam Phi Est
23.	Ph.Nam Phi Est	~	Stung Treng
24.	Phnom Penh	~	Prey Veng
25.	Prey Veng	~	KG.Trabek
26.	KG.Trabek	~	Svay Rieng

PROFILE MAP

(K = 4/3)



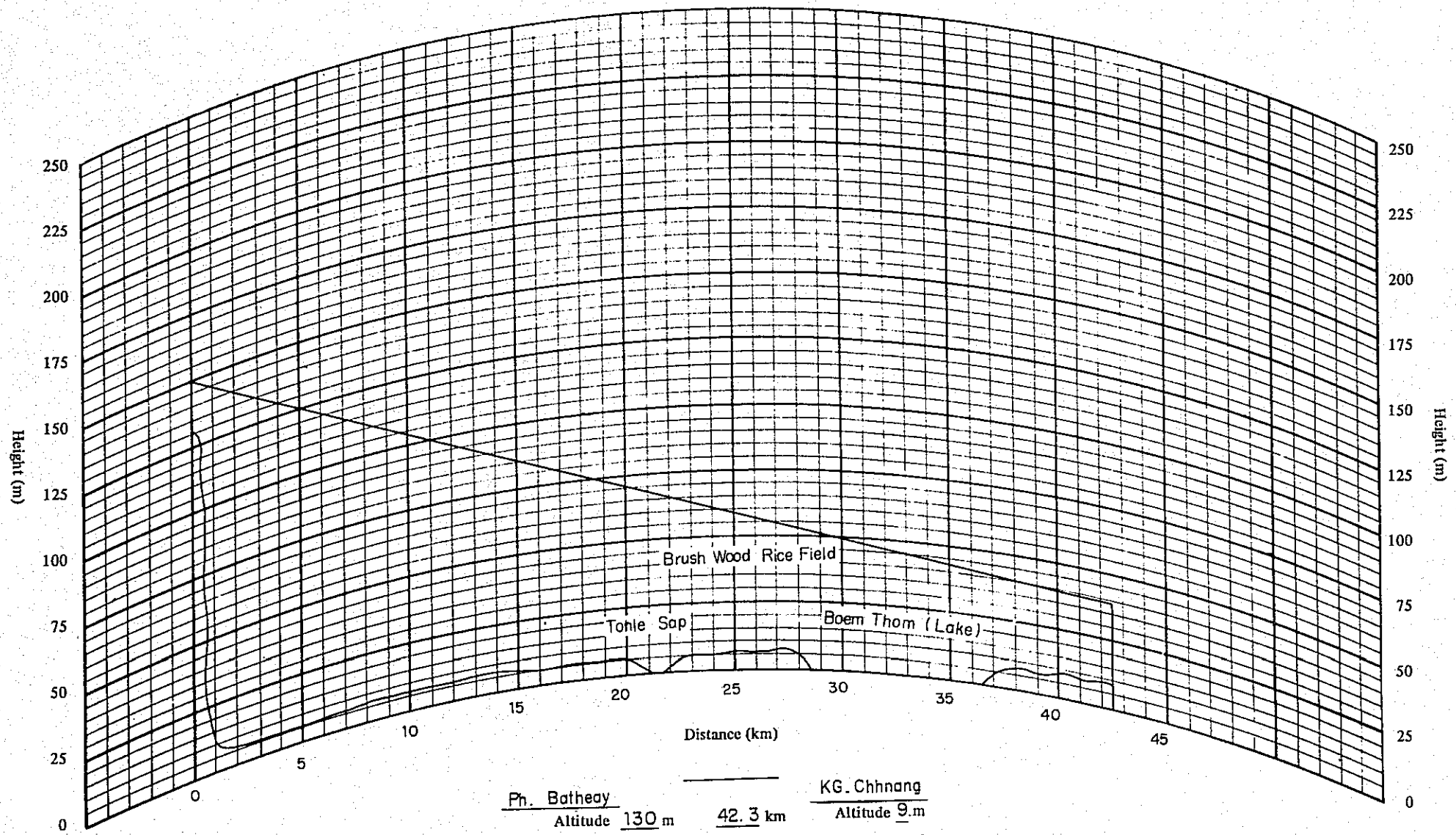
Phnom – Penh
Altitude 10 m
Antenna Height 50 m

47.8 km

Ph. Batheay
Altitude 130 m
Antenna Height 20 m

PROFILE MAP

(K = 4/3)



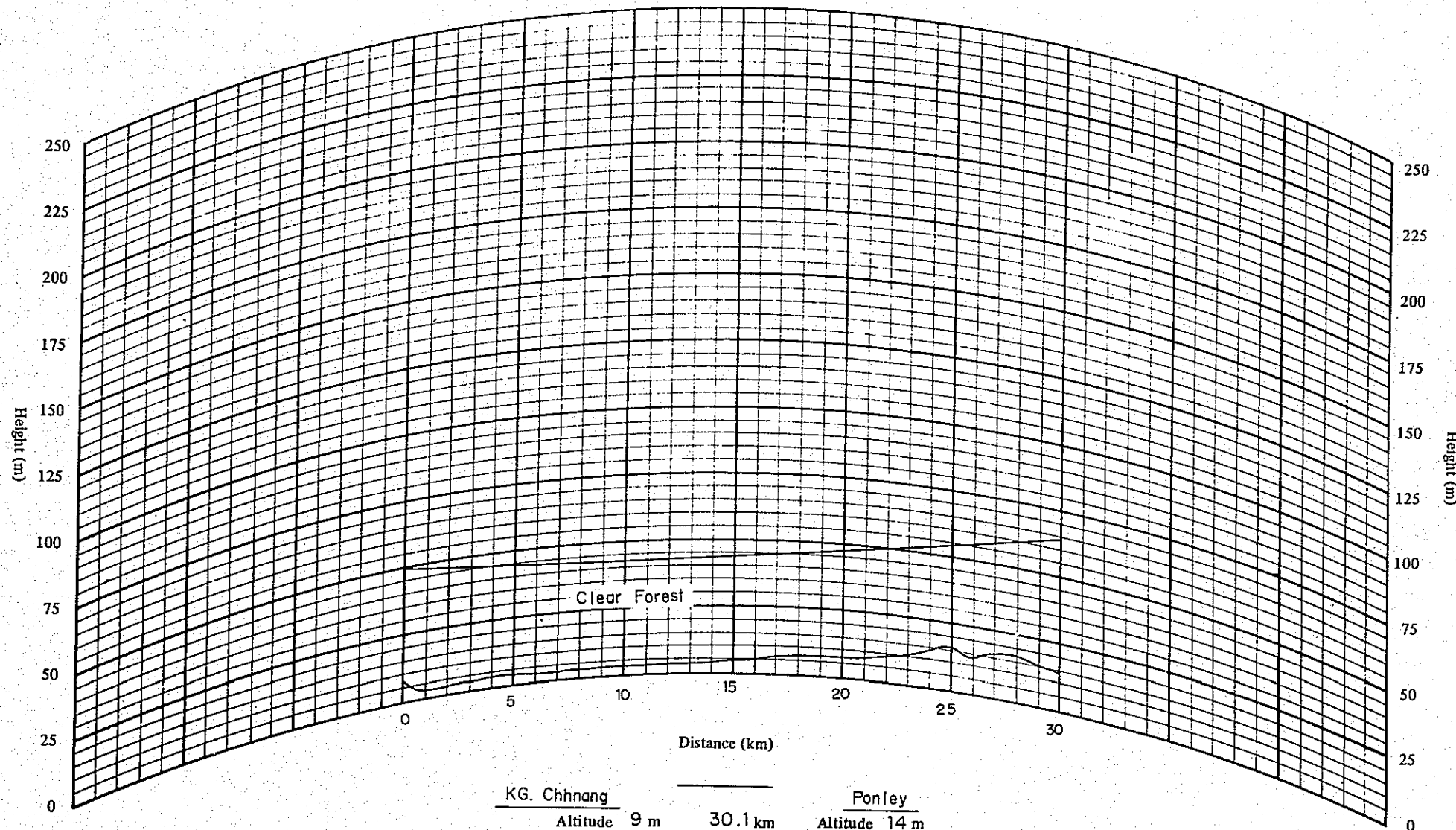
Ph. Batheay — Altitude 130 m — Antenna Height 20 m

42.3 km

KG. Chhnang — Altitude 9 m — Antenna Height 30 m

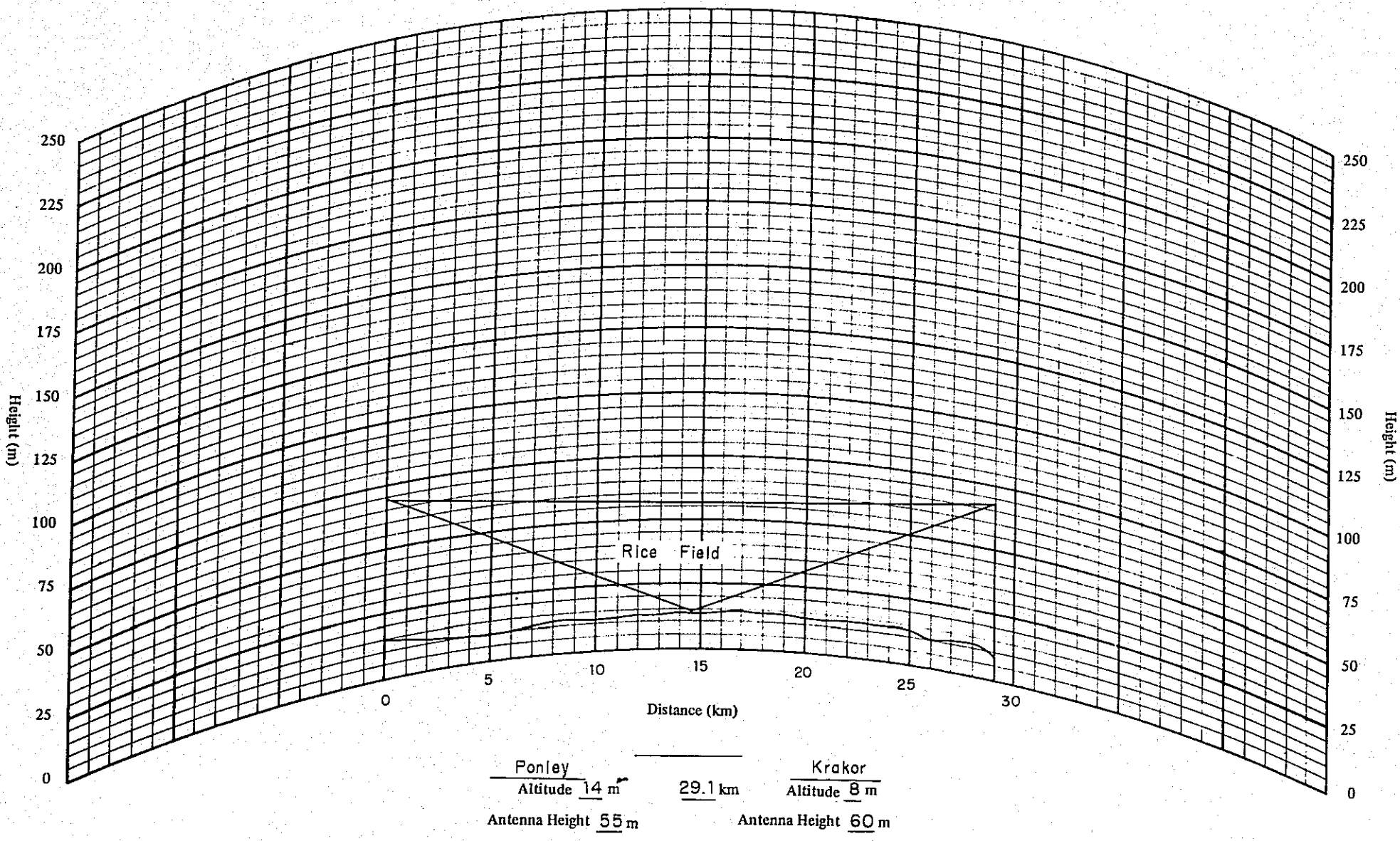
PROFILE MAP

(K = 4/3)



PROFILE MAP

(K = 4/3)



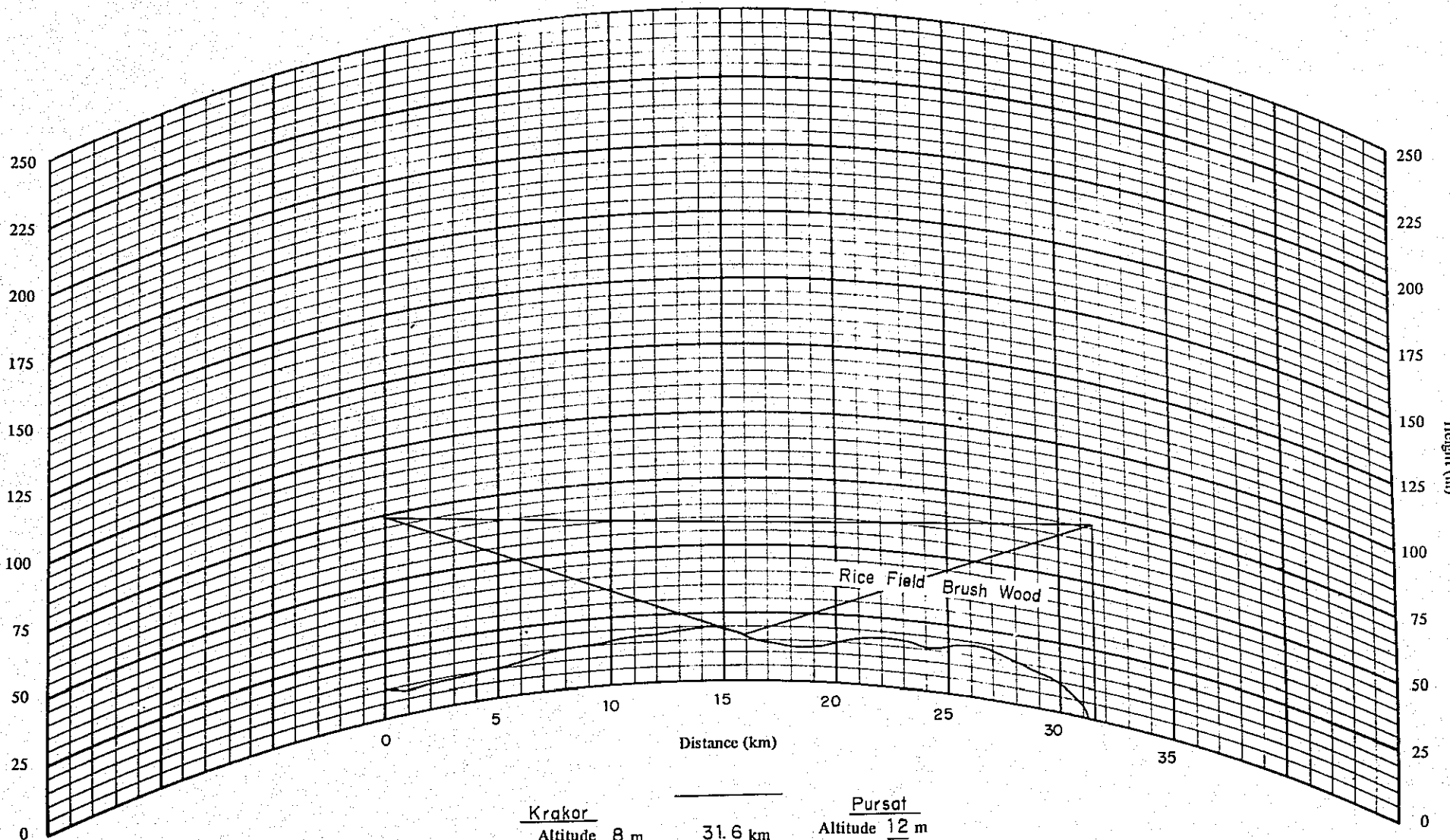
Ponley
Altitude 14 m
Antenna Height 55 m

29.1 km

Krakor
Altitude 8 m
Antenna Height 60 m

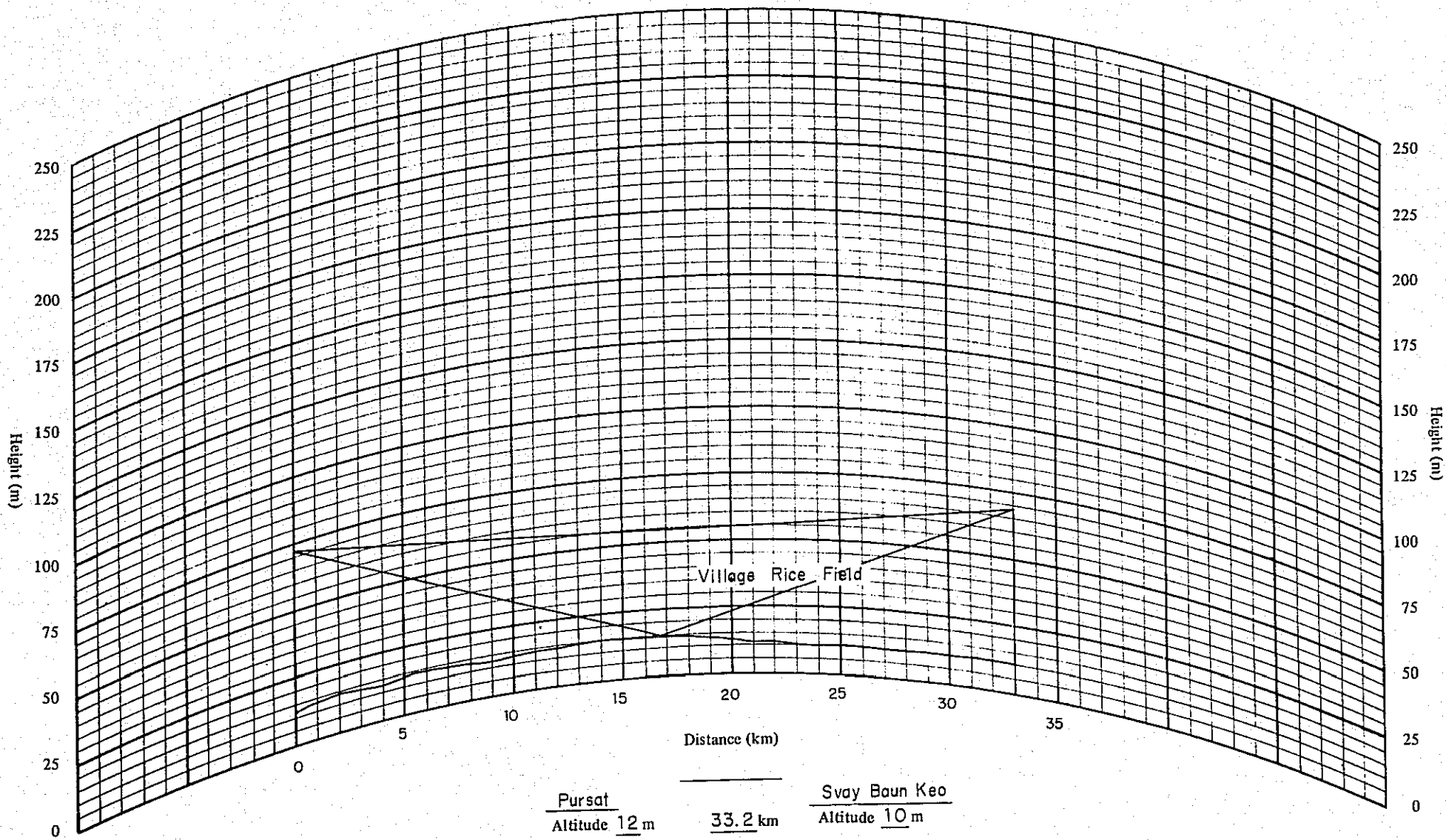
PROFILE MAP

(K = 4/3)



PROFILE MAP

(K = 4/3)



PROFILE MAP

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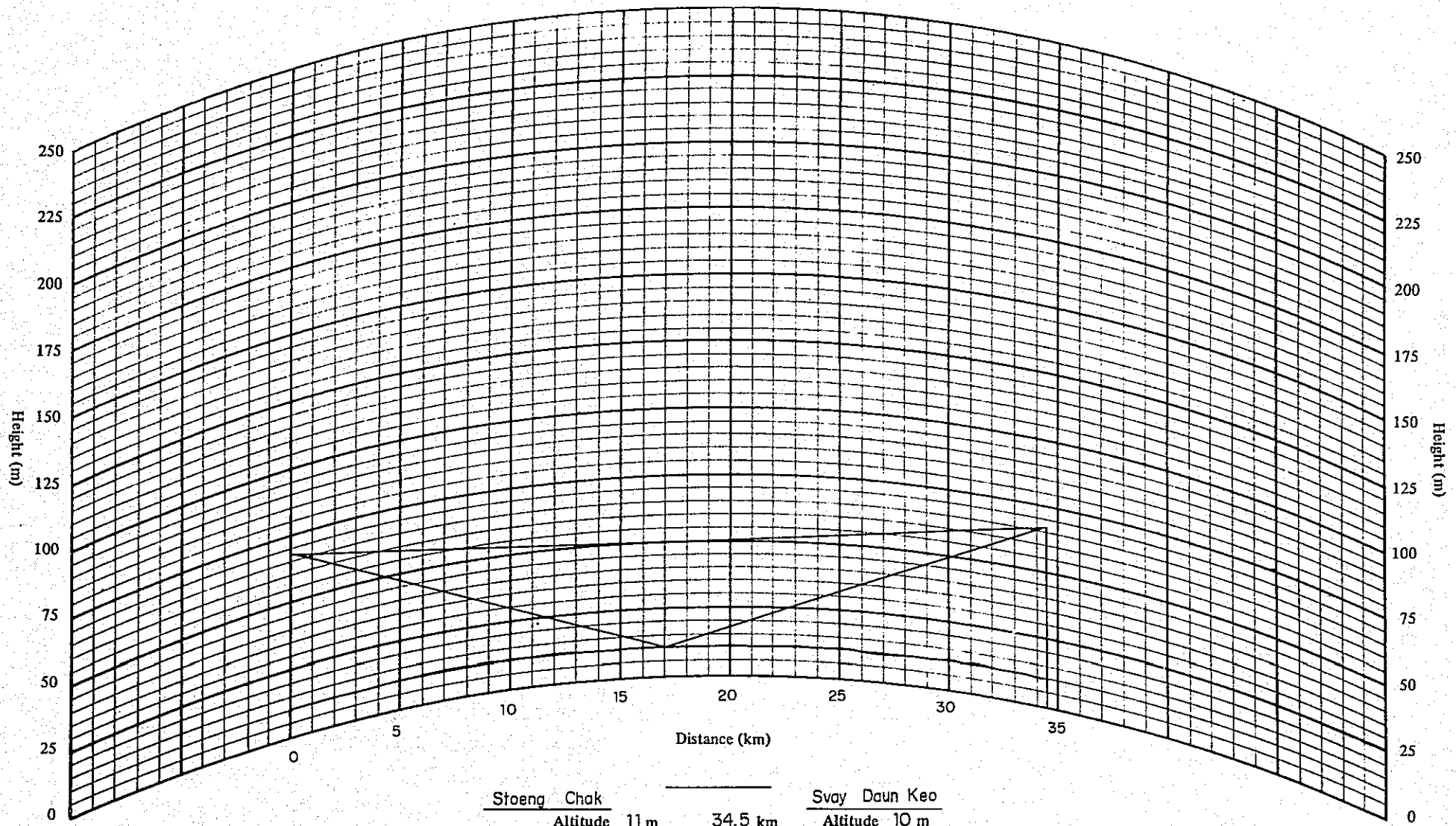


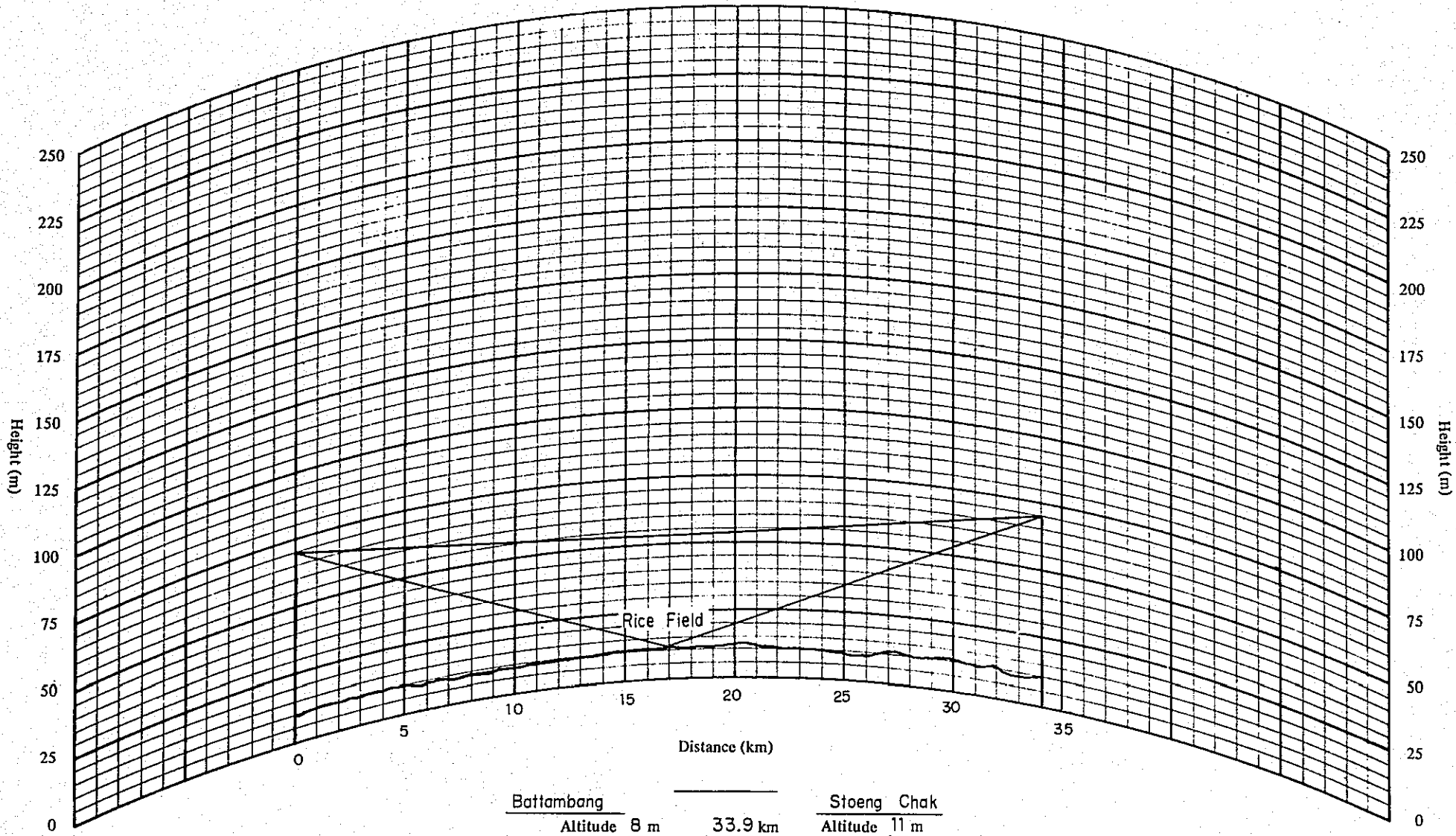
Stoeng Chak — Altitude 11 m — Antenna Height 60 m

34.5 km

Svay Daun Keo — Altitude 10 m — Antenna Height 60 m

PROFILE MAP

(K = 4/3)



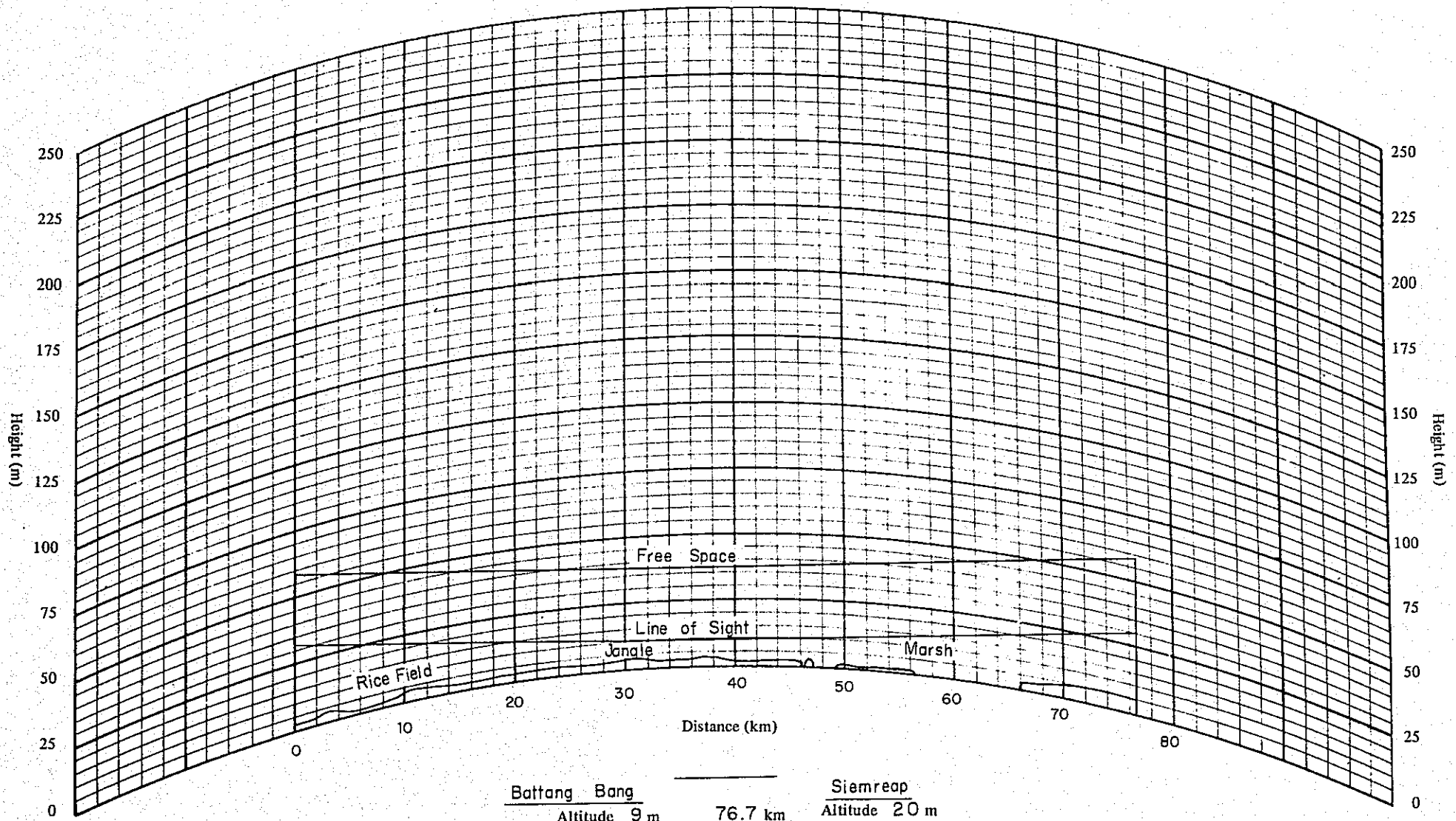
Battambang
Altitude 8 m
Antenna Height 60 m

33.9 km

Stoeng Chak
Altitude 11 m
Antenna Height 60 m

PROFILE MAP

(K = 4/3)



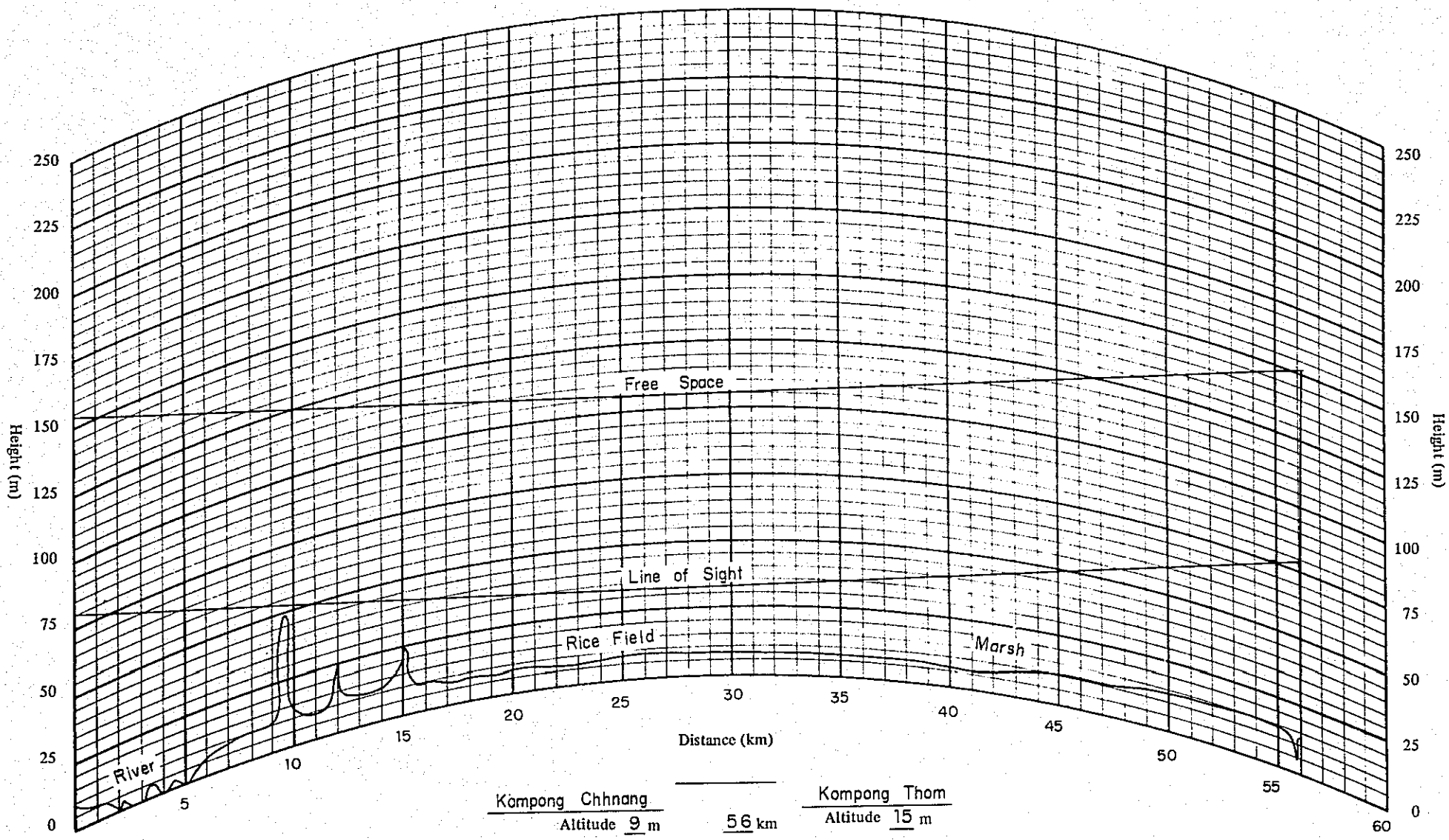
Battang Bang — Altitude 9 m — Antenna Height 226 m (113)

76.7 km

Siemreap — Altitude 20 m — Antenna Height 215 m (102)

PROFILE MAP

(K = 4/3)



PROFILE MAP

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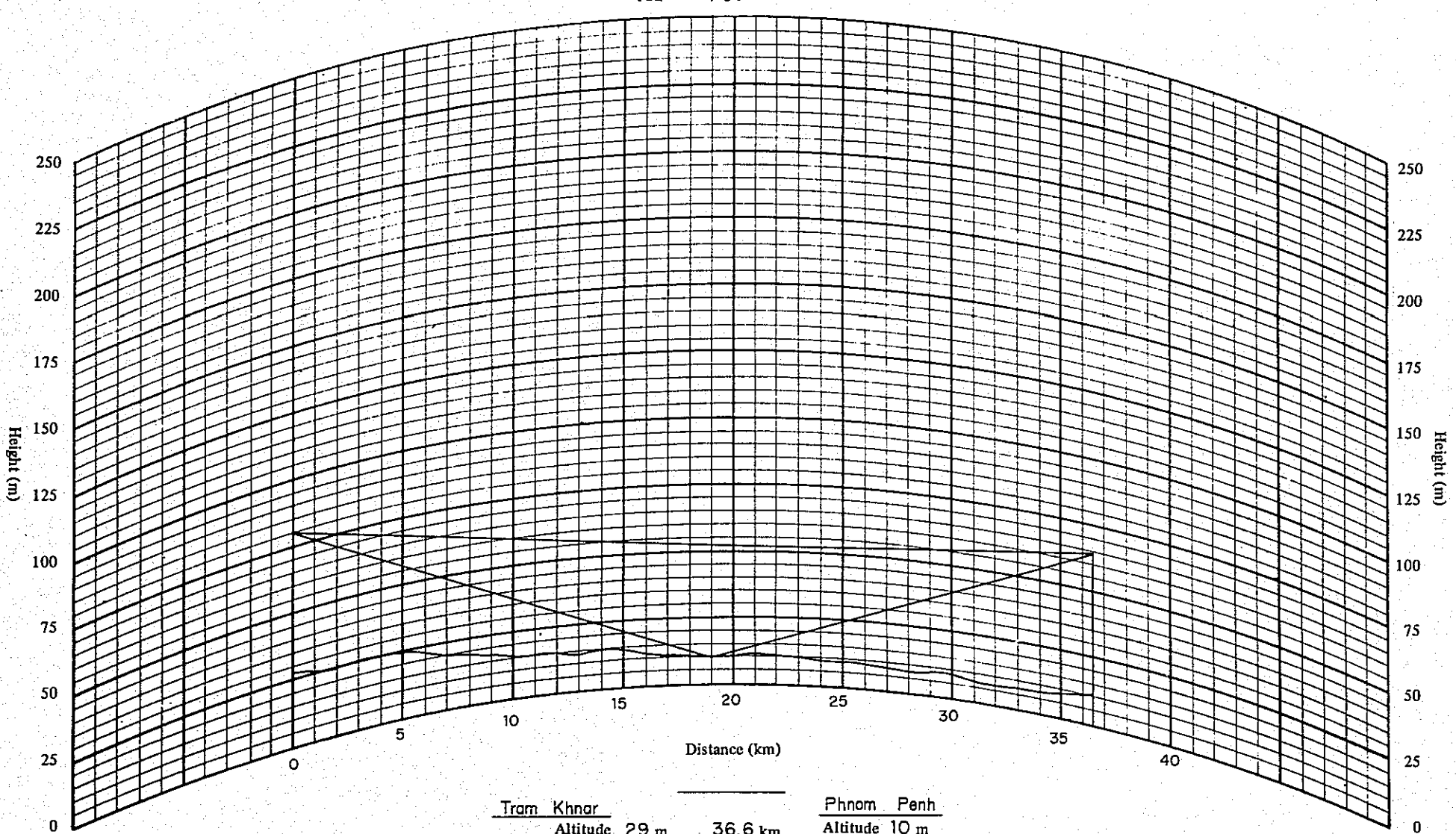

PROFILE MAP

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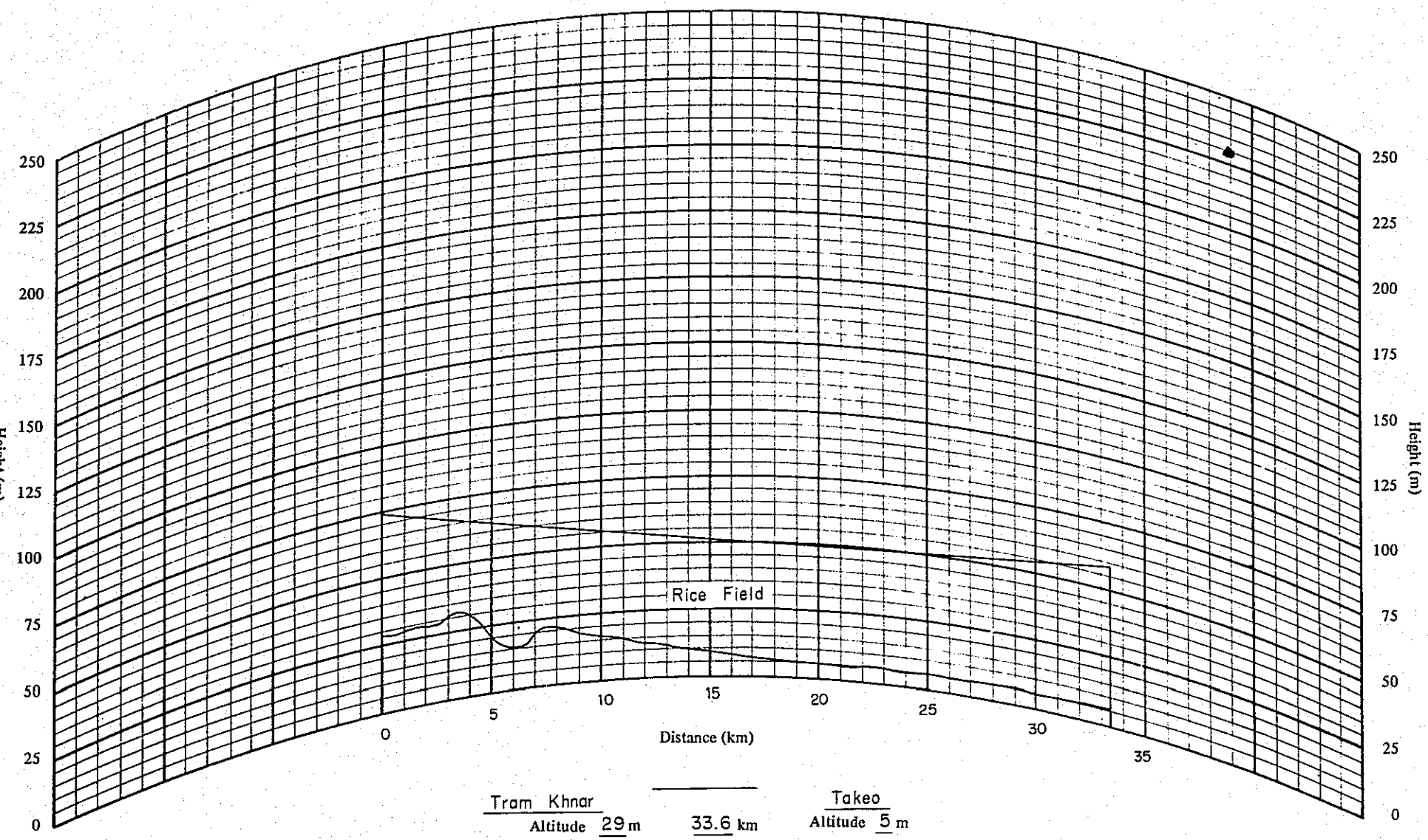


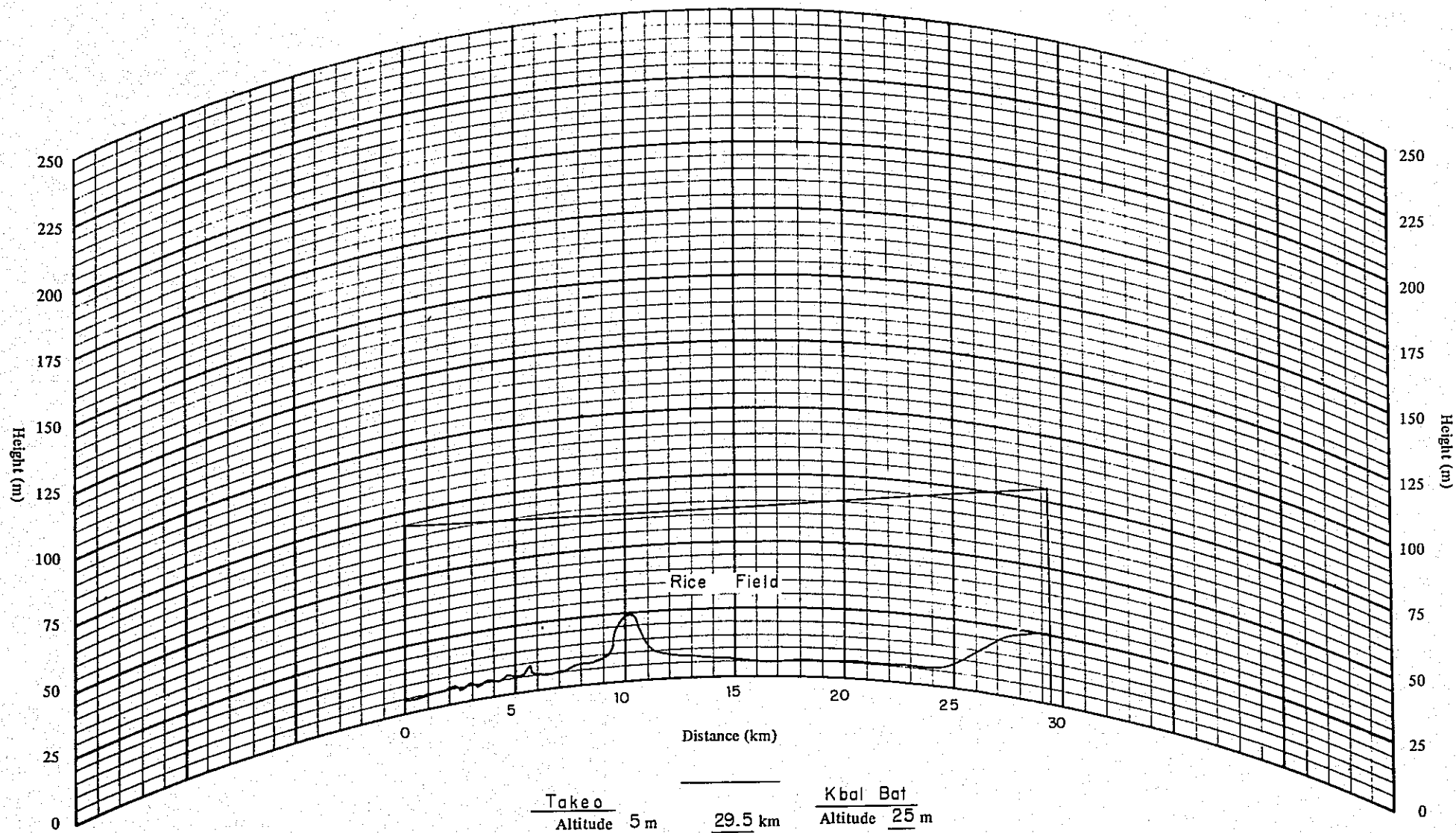
Tram Khnar
Altitude 29 m
Antenna Height 45 m

33.6 km

Takeo
Altitude 5 m
Antenna Height 55 m

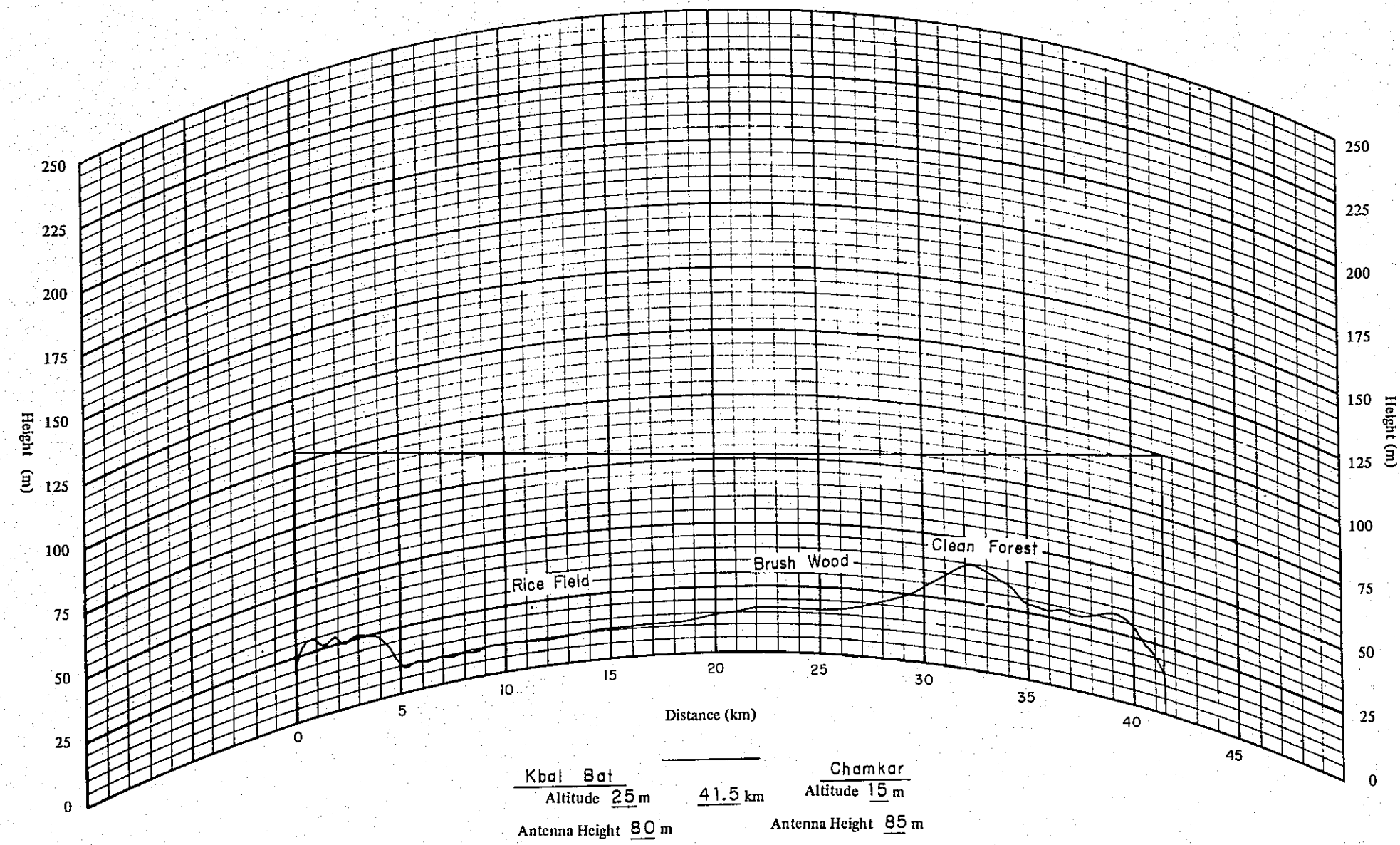
PROFILE MAP

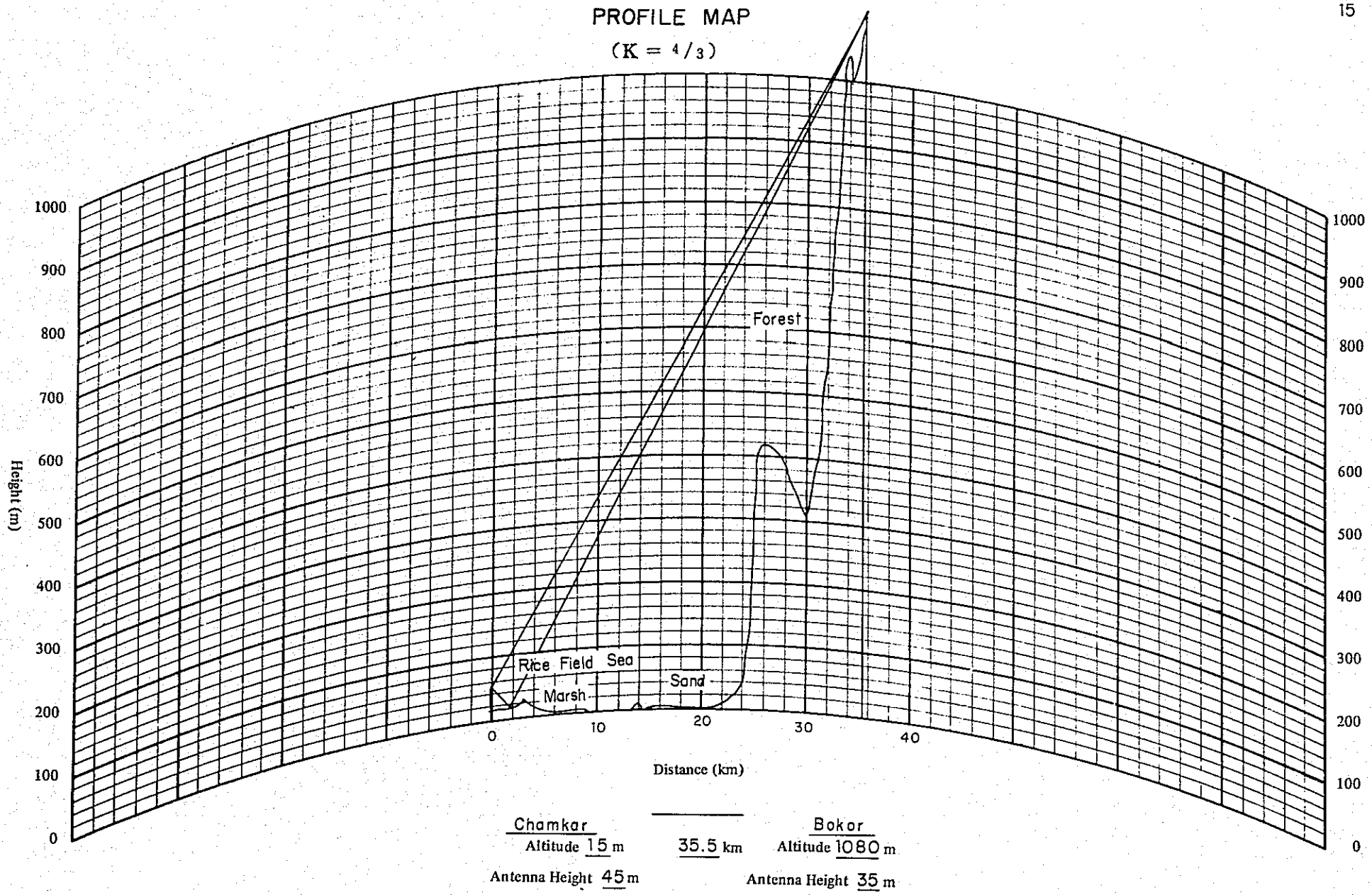
(K = 4/3)



PROFILE MAP

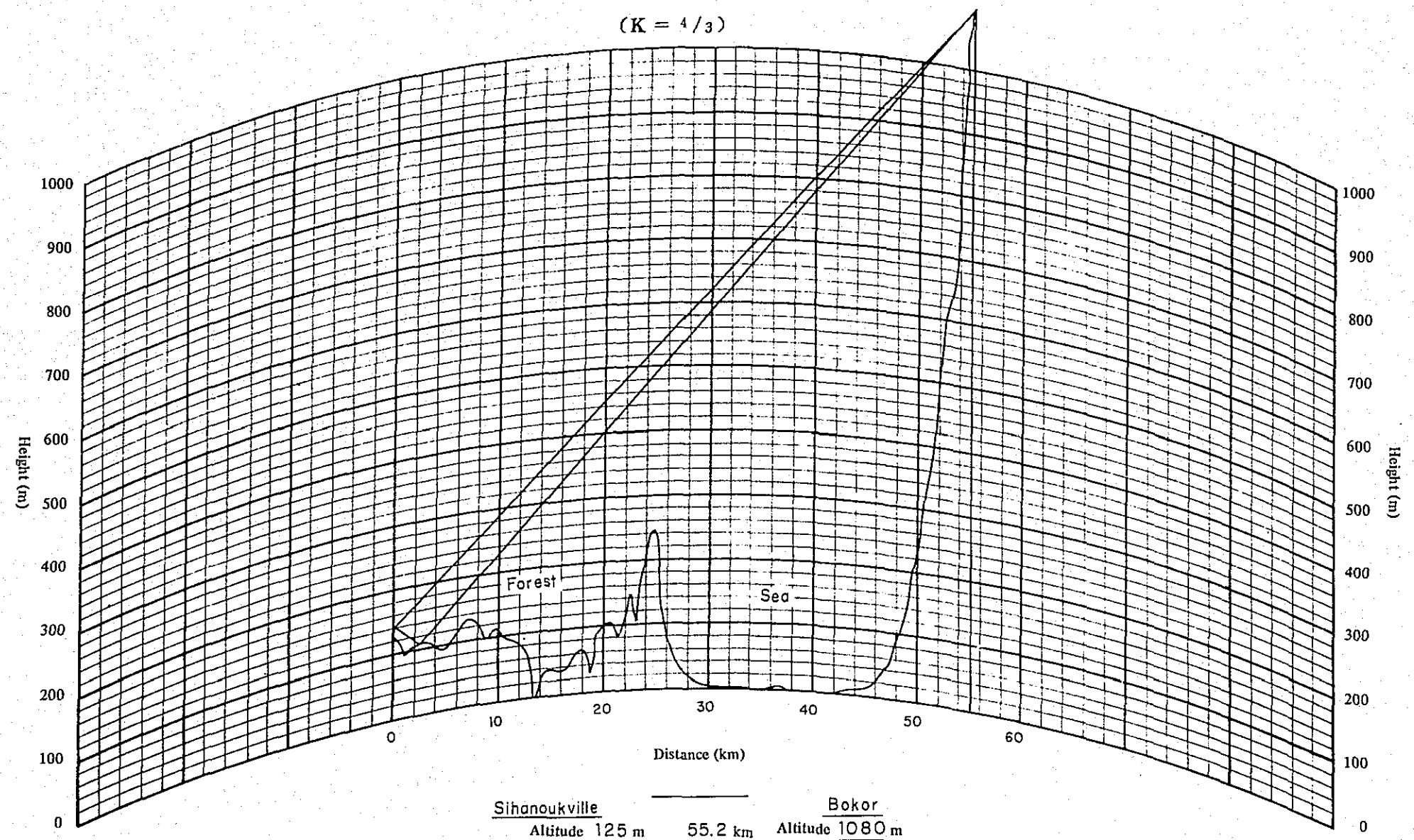
(K = 4/3)




PROFILE MAP
(K = 4/3)
1000
900
800
700
600
500
400
300
200
100
0
Height (m)
Forest
Rice Field
Sea
Marsh
Sand
0
10
20
30
40
Distance (km)
Chamkar
Altitude 15 m
Antenna Height 45 m
35.5 km
Bokor
Altitude 1080 m
Antenna Height 35 m

PROFILE MAP

(K = 4/3)



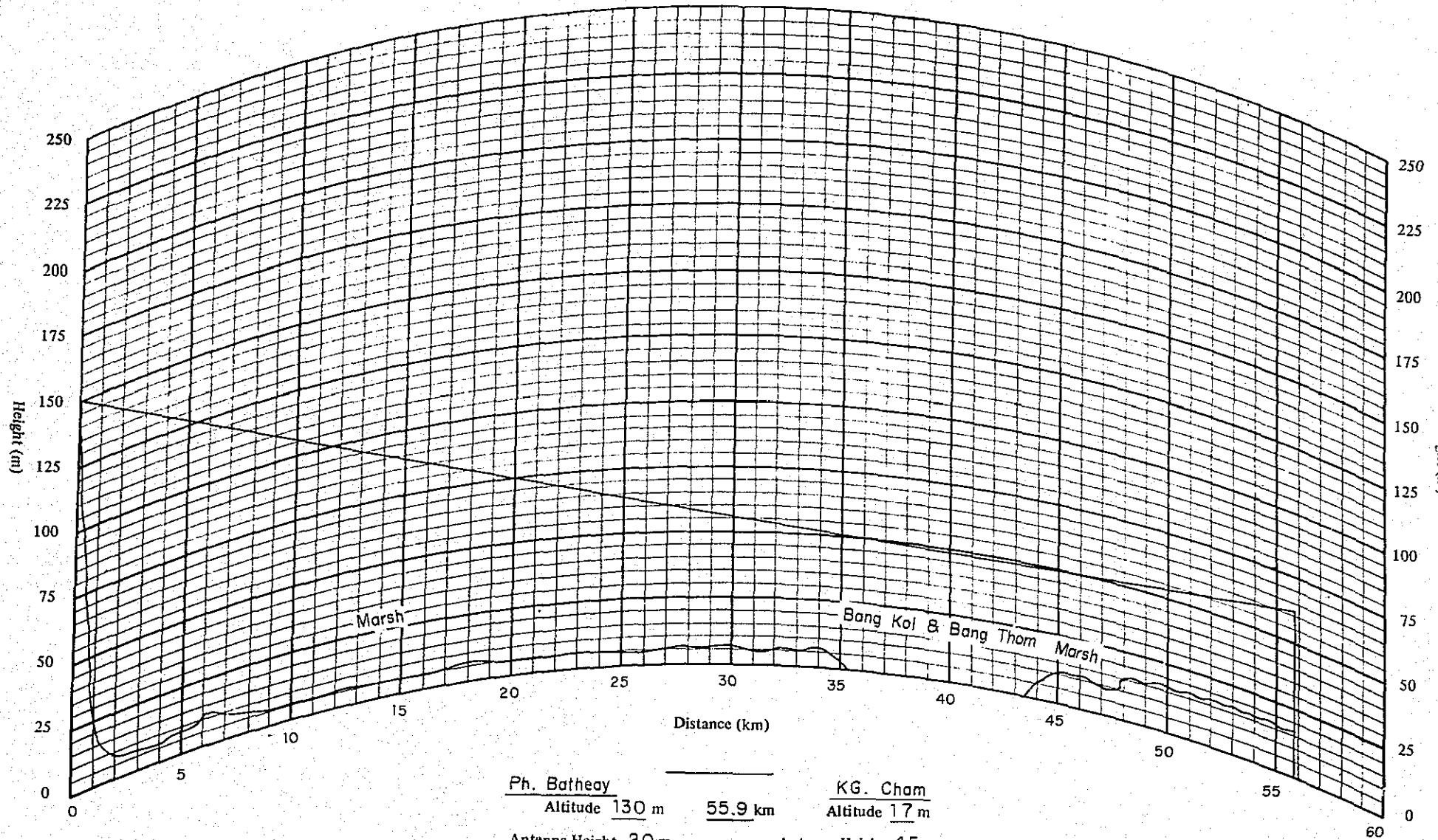
Sihanoukville
Altitude 125 m
Antenna Height 20 m

55.2 km

Bokor
Altitude 1080 m
Antenna Height 20 m

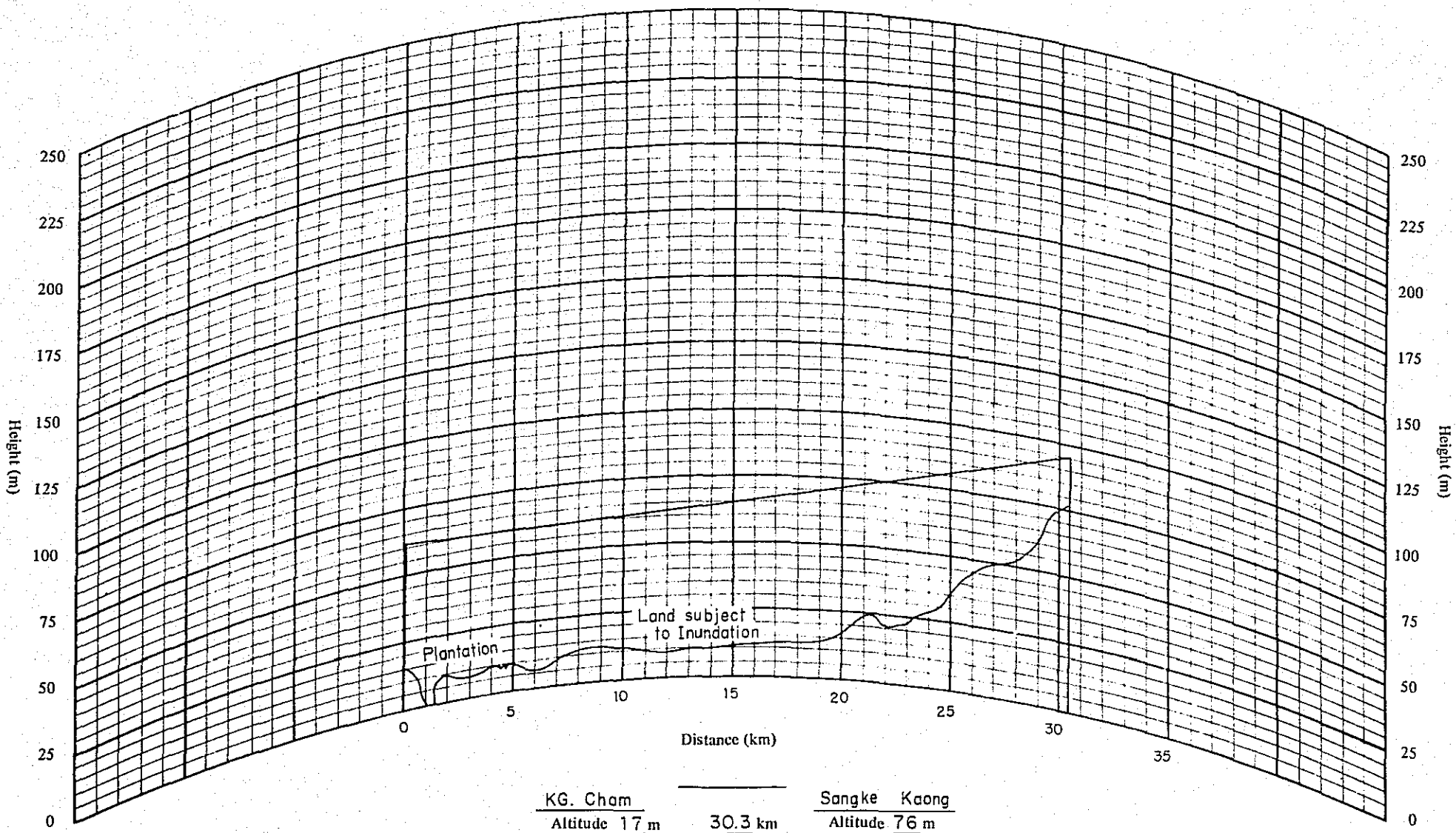
PROFILE MAP

(K = 4/3)



PROFILE MAP

(K = 4/3)



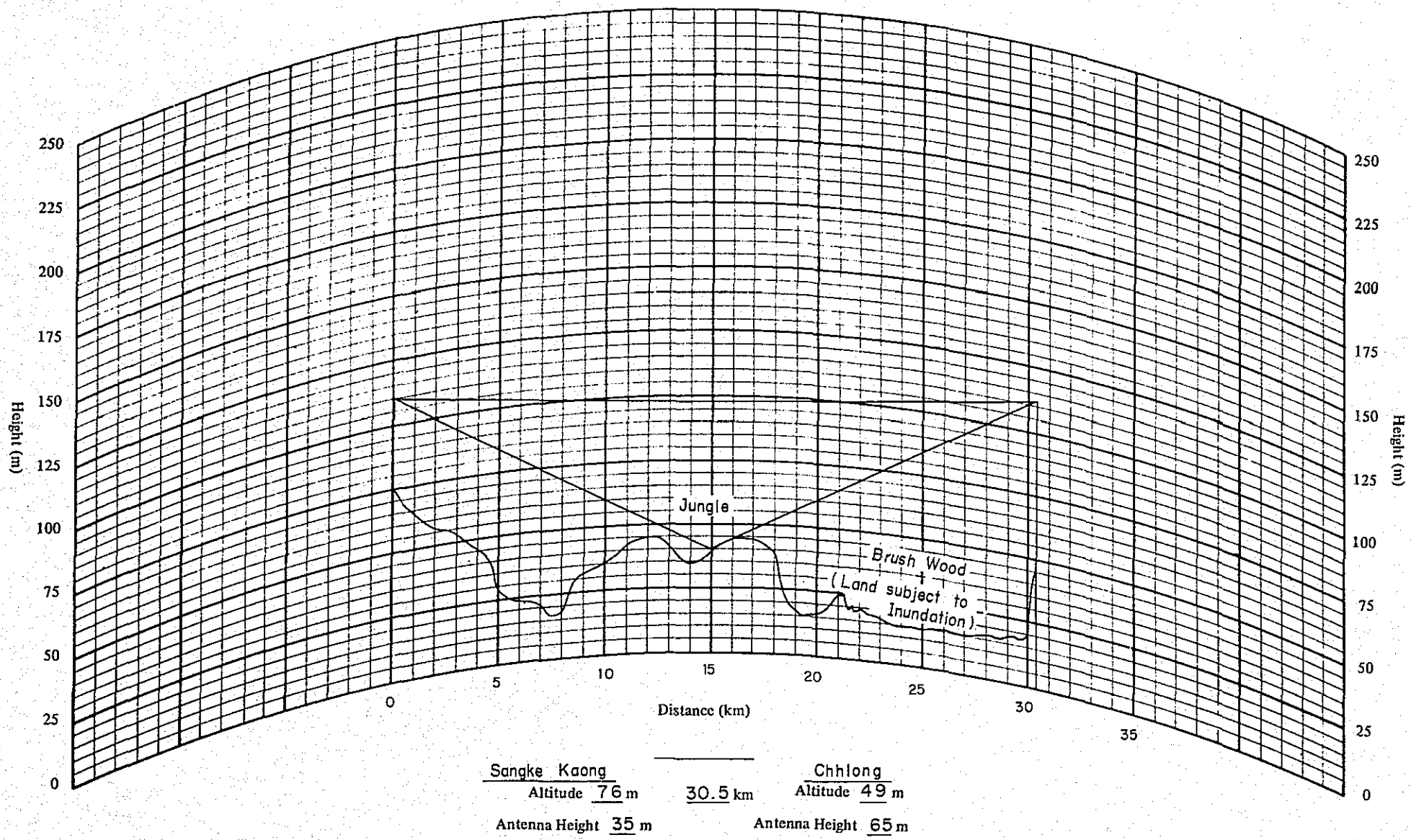
KG. Cham — Altitude 17 m — Antenna Height 45 m

30.3 km

Sangke Kaong — Altitude 76 m — Antenna Height 20 m

PROFILE MAP

(K = 4/3)



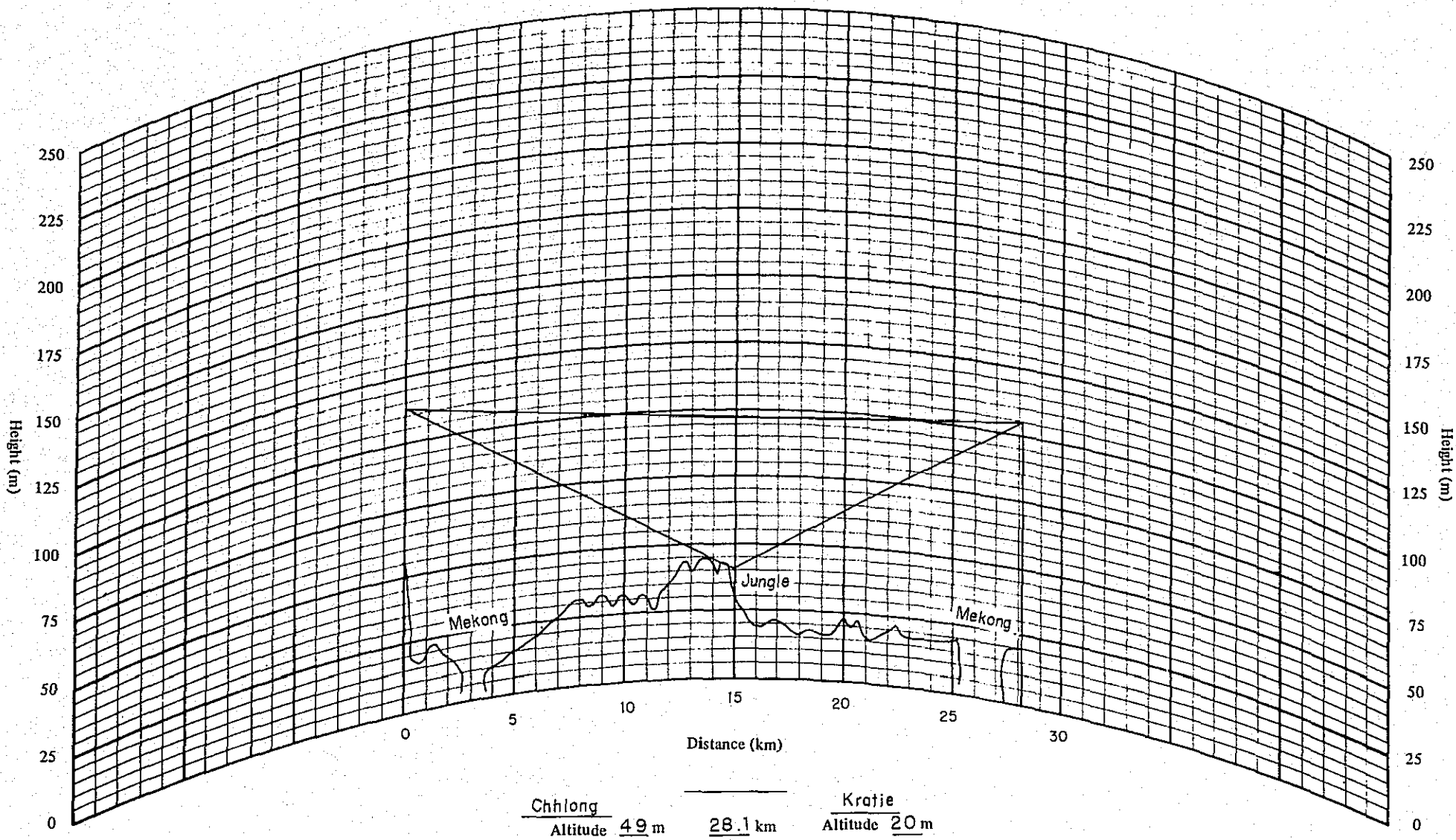
Sangke Kaong
Altitude 76 m
Antenna Height 35 m

30.5 km

Chhlong
Altitude 49 m
Antenna Height 65 m

PROFILE MAP

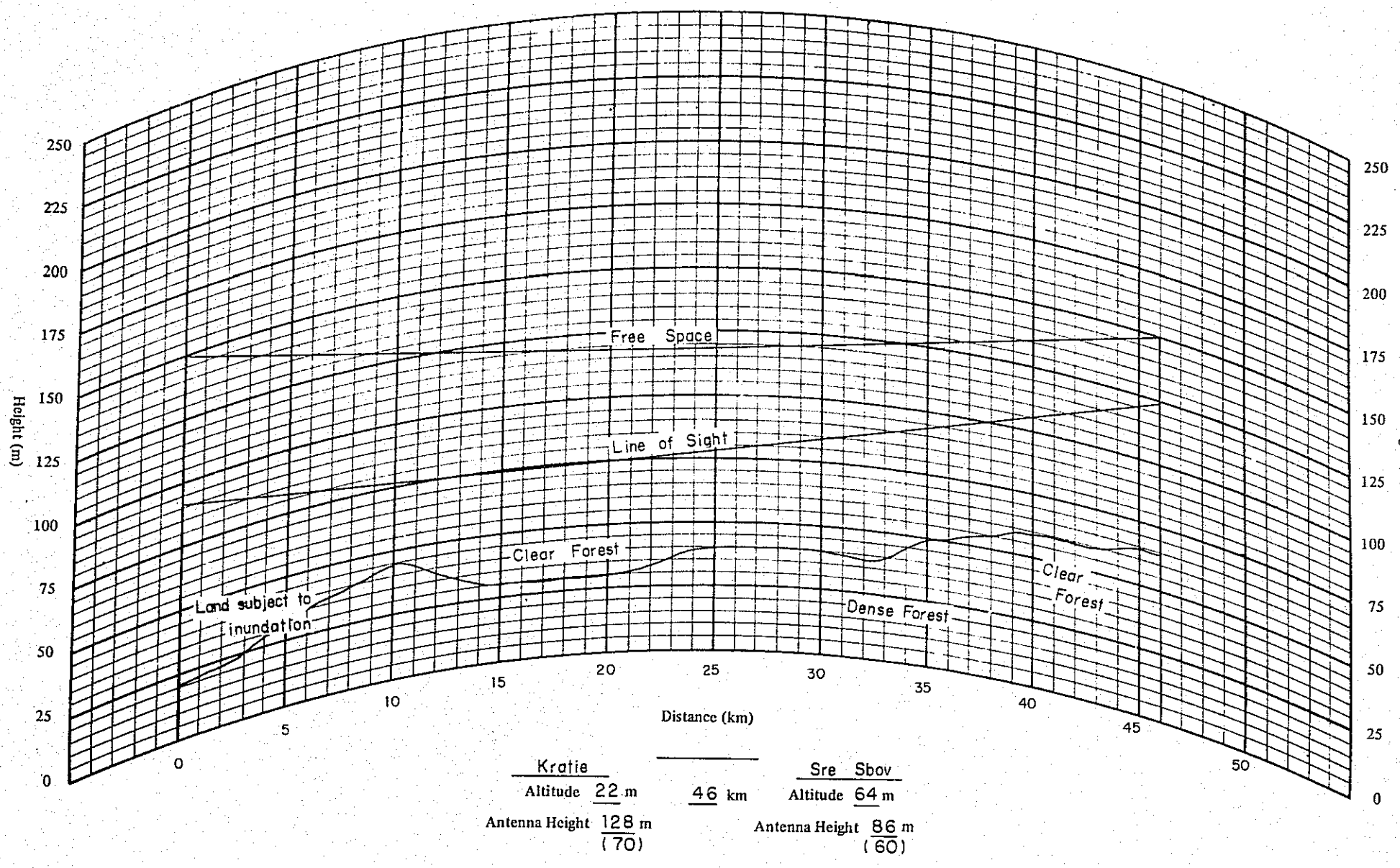
(K = 4/3)



Chhlong		Kratie
Altitude 49 m	28.1 km	Altitude 20 m
Antenna Height 65 m		Antenna Height 85 m

PROFILE MAP

($K = 4/3$)



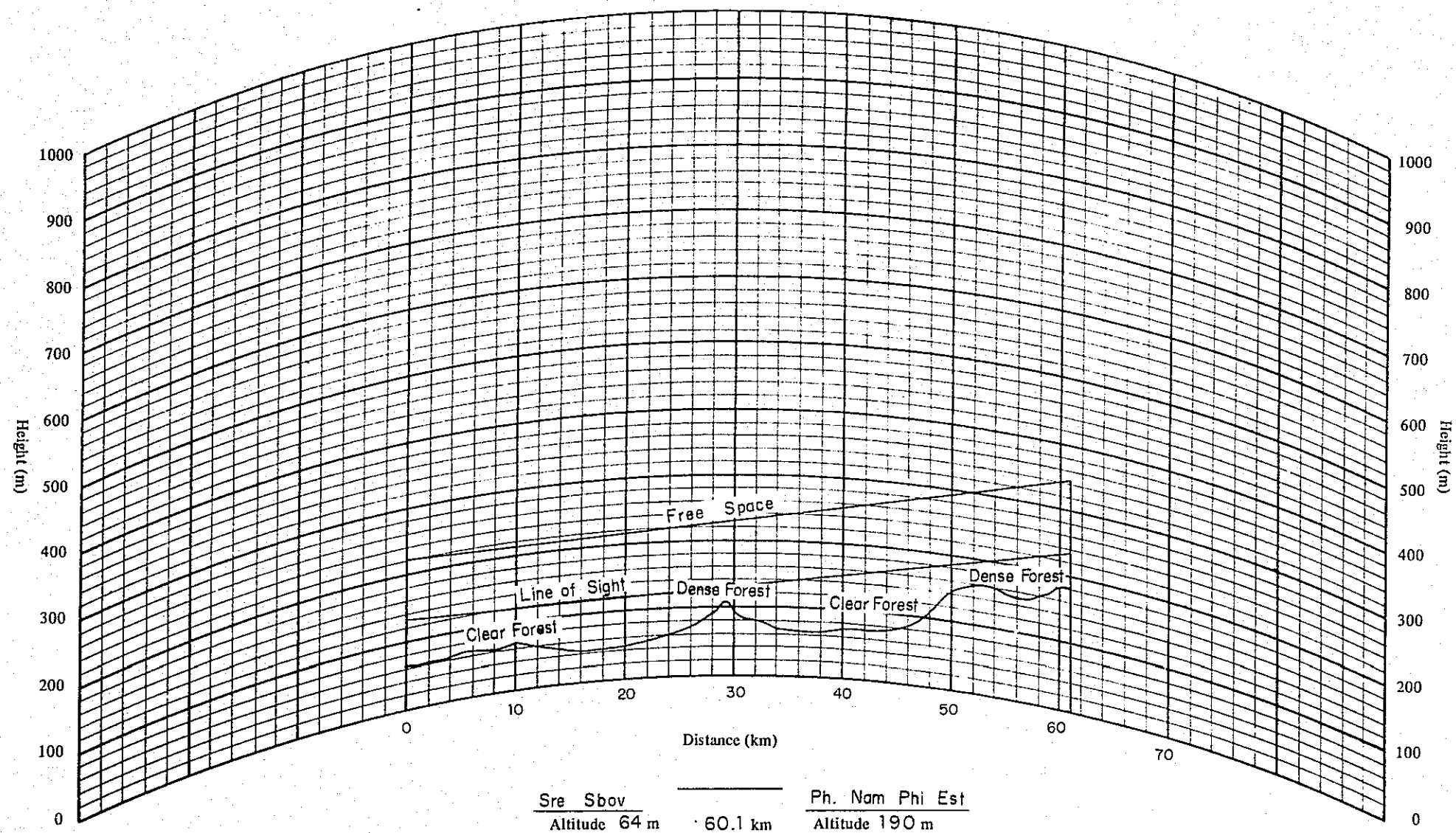
Kratie
Altitude 22 m
Antenna Height 128 m (70)

46 km

Sre Sbov
Altitude 64 m
Antenna Height 86 m (60)

PROFILE MAP

(K = 4/3)



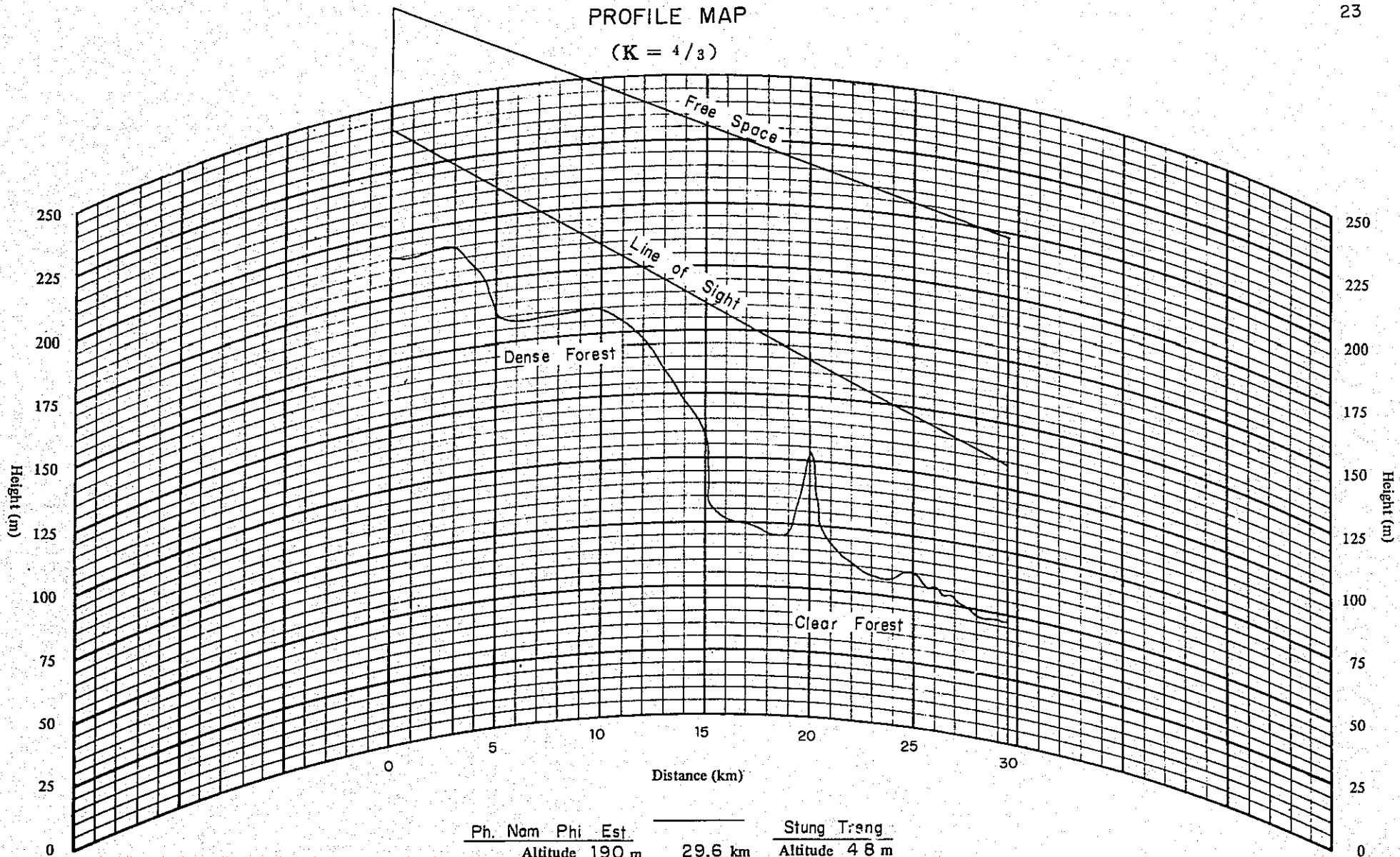
Sre Sbov — 60.1 km — Ph. Nam Phi Est

Altitude 64 m — Altitude 190 m

Antenna Height 160 m (66) — Antenna Height 160 m (50)

PROFILE MAP

(K = 4/3)



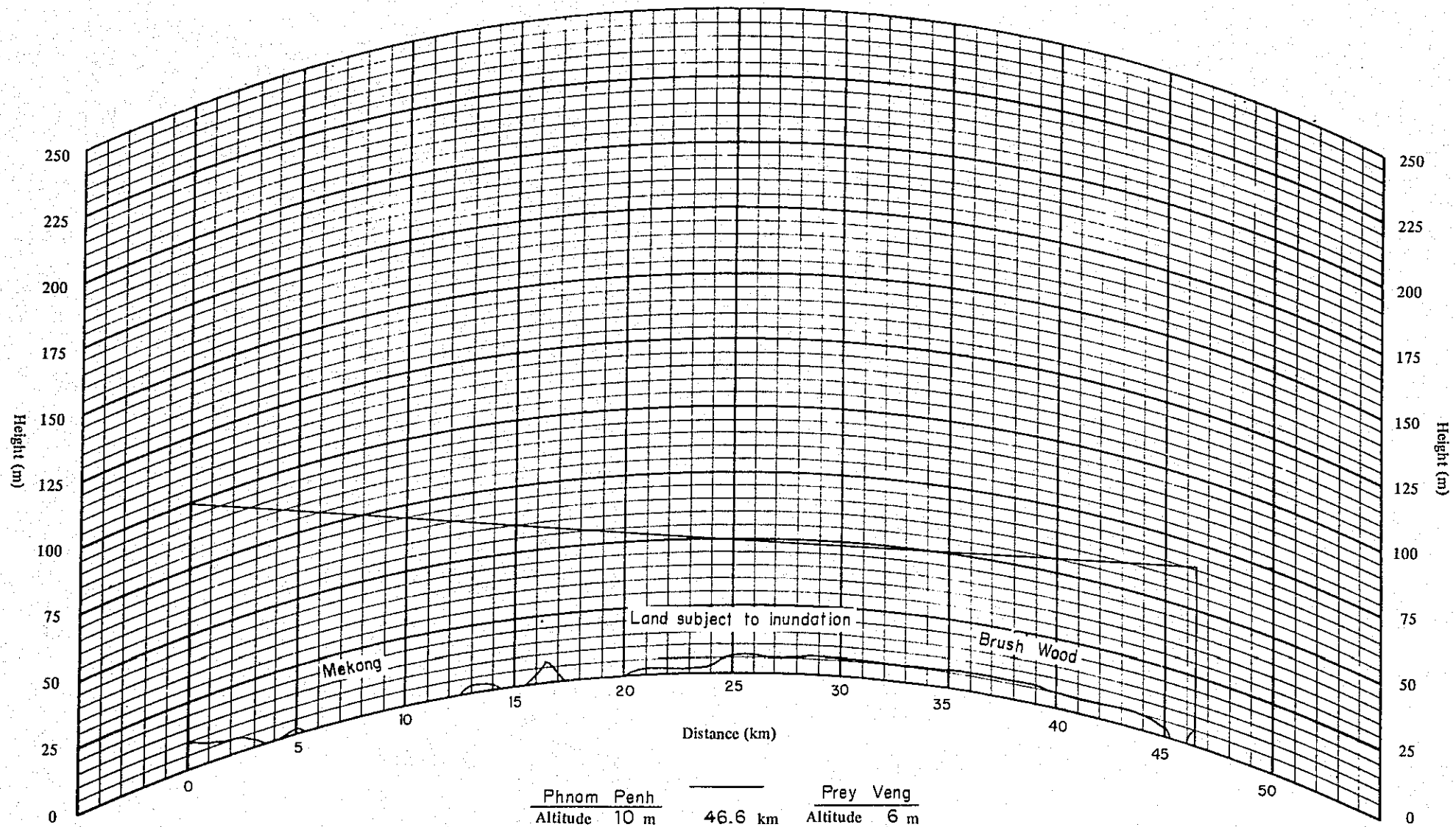
Ph. Nam Phi Est
Altitude 190 m
Antenna Height 100 m (50)

29.6 km

Stung Trang
Altitude 48 m
Antenna Height 150 m (60)

PROFILE MAP

(K = 4/3)



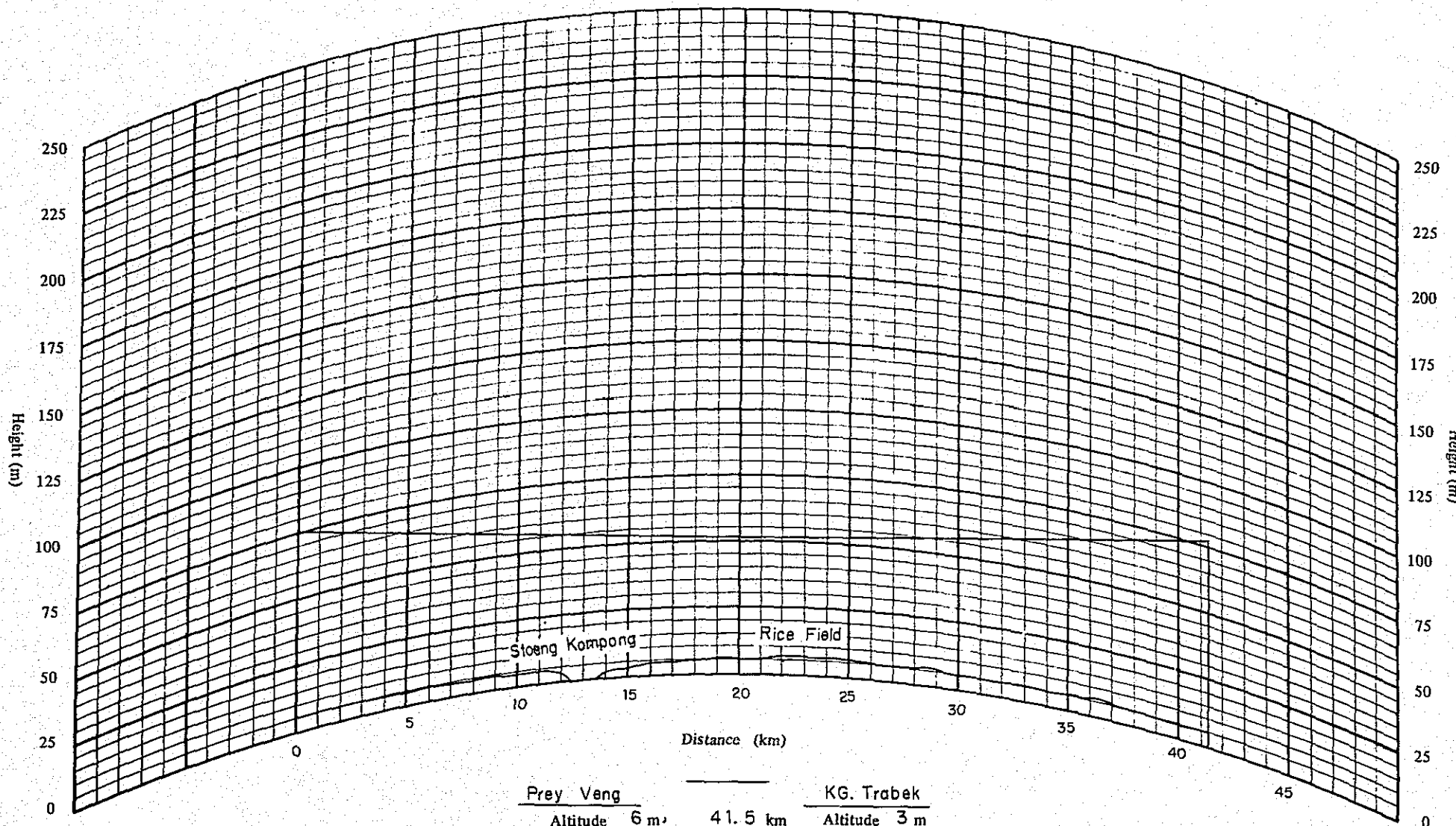
Phnom Penh — Altitude 10 m — Antenna Height 90 m

46.6 km

Prey Veng — Altitude 6 m — Antenna Height 60 m

PROFILE MAP

(K = 4/3)



PROFILE MAP

(K = 4/3)