AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY

1. SUBJECT CLASSIFICATION

A. PRIMARY: Science and Technology

B. SECONDARY: Science and Technology

2. TITLE AND SUBTITLE

Radio broadcasting and telecommunications in Nepal

3. AUTHOR(S)

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4. DOCUMENT DATE: 1975

5. NUMBER OF PAGES: 25p.

6. ARC NUMBER: ARC NP-384-R234

7. REFERENCE ORGANIZATION, NAME AND ADDRESS

Massachusetts Institute of Technology
Center for International Studies
Cambridge, Massachusetts 02139

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)

9. ABSTRACT

In previous studies the authors considered the possible use of television for educational purposes in Brazil and India and, in a very cursory way, of radio and television in Ethiopia. The analyses focused entirely on the means of delivering "the message" to the television or radio receiver, e.g. by satellite, terrestrial microwave links, physical delivery of film or tapes, etc. without making judgements as to whether or not television, or radio, would be effective, and in particular cost-effective, as a medium for instruction, either in the schools or for adult education.

They felt that those analyses, and others of a similar nature, were inadequate in that they focused on the question of communications for education in isolation, failing to treat adequately the possibility that the same communications links might be used with benefit not just for education but for a number of purposes, indeed, with educational radio or TV often being a secondary user. This led them in this study and in a companion document to consider the question of communication from a broader perspective as they extended their studies to Nepal and Indonesia.

The discussion of problems and possibilities in the case of Nepal is somewhat arbitrarily divided into three parts: radio broadcast services generally, radio for education in the schools, and two-way telecommunications. They have not treated the possibility of television, feeling that the costs, difficulties of maintainence, and problems of power supply make it unrealistic at this time as a communications medium for Nepal, except possibly for the Kathmandu Valley. Neither have they concerned themselves with the problems of mail and newspaper distribution. Their analysis is based largely on information obtained during a visit to Nepal in late May-early June 1974.

10. CONTROL NUMBER: PN-AAB-169

11. PRICE OF DOCUMENT

12. DESCRIPTORS: Radio broadcast services, Radio for education in the schools, two way telecommunications, television

13. PROJECT NUMBER: 931-11-690-896

14. CONTRACT NUMBER: CM/ta-C-73-9

15. TYPE OF DOCUMENT: Research Study

AID 590-1 (4-74)

C/75-3

RADIO BROADCASTING AND TELECOMMUNICATIONS IN NEPAL

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Robert Butman
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This report has been prepared under contract
with the Bureau for Technical Assistance,
U.S. Agency for International Development

Center for International Studies
Massachusetts Institute of Technology
Cambridge, Massachusetts 02139

January 1975

RADIO BROADCASTING AND TELECOMMUNICATIONS IN NEPAL

George Rathjens
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In previous studies we considered the possible use of television for educational purposes in Brazil and India and, in a very cursory way, of radio and television in Ethiopia.[1] The analyses focused entirely on the means of delivering "the message" to the television or radio receiver, e.g. by satellite, terrestrial microwave links, physical delivery of film or tapes, etc. without making judgements as to whether or not television, or radio, would be effective, and in particular cost-effective, as a medium for instruction, either in the schools or for adult education.

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[1] Technical-Economic Considerations in Public Service Broadcast Communications for Developing Countries, Robert C. Butman, George W. Rathjens, Colin J. Warren, AED, Report Number Nine, 1973.

[2] R.C. Butman, Telecommunications Development in Indonesia , Dec. 1973

except possibly for the Kathmandu Valley. Neither have we concerned ourselves with the problems of mail and newspaper distribution.

Our analysis is based largely on information obtained during a visit to Nepal in late May-early June 1974. We benefited greatly from discussions with a number of people who gave generously of their time, in particular:

B.R. Baidya
HMG's Director General of Health

M. Mohsin
National Education Committee

U. B. Nakarmi
HMG's Director of Telecommunications

B.B. Pradhan
HMG's Secretary of Finance

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General Manager, Royal Nepal Airlines Corporation

Pashupati Rana
Honorable Member, Raskiya Panchayat

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W. C. Ide, Chief of USAID Mission to Nepal

L. D. Bomberger, also of USAID

Roger Cranse, New Educational Reform Associates, Inc.

Miss Gayan, Colombo Plan Expert

Needless to say, none of them are in any way responsible for any of the conclusions we have drawn.

Since the preparation of the first draft of this report there have been two additional studies of considerable relevance: one prepared by New Educational Reform Associates, Radio Listening Patterns in Nepal, 1974; and a UNICEF document by N. L. Sahdev, Development of Broadcasting for National Advancement. We have made a number of changes in our text in the light of those studies (referred to hereafter as the New Era and Sahdev studies).

I. Radio Broadcasting

Radio Nepal now broadcasts some 85 hours a week from Kathmandu with transmission at 790 kHz (10 kilowatts) and also in the 40, 60 and 90 meter bands (100 kilowatts). All programs are in Nepali except for limited services in English.

Putting aside for the moment the special question of the use of radio for educational purposes, we turn to the possibility of further development of broadcasting in Nepal, raising three kinds of questions: the issues of program content and language; the question of geographical coverage; and questions relating to taxation and duties on radios and their manufacture.

1) Program Content and Language.

Surveys made several years ago (1969-70)[1] indicated that a substantial fraction of the population of Nepal preferred to listen to radio stations other than Radio Nepal, particularly to All India Radio, but also to Radio Ceylon and the BBC.[2] Indeed, in some parts of the country All India Radio was more popular than Radio Nepal. Several informants have suggested that this still may be true and have identified some probable reasons. Firstly, there is the question of program content. Some observers felt that greater attention must be placed on development by Radio Nepal of attractive programs if it is to compete effectively in areas where other programs can be easily heard. Secondly, there is the language question. According to the 1961 census Nepali was the first language of 51% of Nepalese.[3] Many others understand it in varying degrees, but fairly large numbers will presumably prefer to listen to radio in languages with which they are more familiar, if they can receive such broadcasts. Particularly in the Terai (Southern Nepal), where large numbers of people speak Indian languages, Radio Nepal would be at a disadvantage in competing with All India Radio, even aside from the question of program content.[4] There is a question, then, as to whether broadcasting by Radio Nepal in languages other than Nepali would

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[1] Report on the Radio Listener Analysis Survey, Dan Taylor and Ham Hamal

[2] The New Era survey reports 81% of respondents listen to other stations in addition to Radio Nepal. The figure is 95% for the eastern, central and western Terai taken together.

[3] Kamal P. Malla in Nepal in Perspective, edited by PSJB Rana and K. P. Malla, CEDA Kathmandu, 1973.

[4] In 1961 little more than 10% of the Terai population spoke hill languages such as Newari or Nepali, as their mother tongue, The People of Nepal, Dor Bahadur Bista, Kathmandu, 1971. 29% and 16% of the respondents to the New Era Survey in the central and eastern Terai respectively indicated they did not understand the language of Radio Nepal.

increase its coverage. To some extent this would be possible without interfering with present broadcast schedules since Radio Nepal is now off the air from 930 to 1300 and from 1600 to 1730 (local time).[1] Filling this off-the-air time with programs in language other than Nepali could be done at little cost, but extensive use of other languages would imply additional transmission facilities and greater cost. There is a question as to whether such expansion would be desirable from the perspective of the Government of Nepal, given its policy of trying to make Nepali the national language. We make no judgement about this but simply flag it as a question that will have to be faced.

2) Geographical Coverage

Until the New Era Survey we had conflicting reports and no reliable data about the coverage achieved by Radio Nepal. Indeed, we had no good estimate of the number of radios in the country having heard figures as low as 30,000 and as high as 150,000.[2] The range has been much narrowed as a result of the survey which uses a figure of 115,000 (for 1974) with upper and lower bounds of 151,000 and 90,000 on their estimates, and there is now greatly improved information about the quality of reception and about listening habits. This enables us to discuss systems changes with more confidence than was possible last summer, but lacking information on field strength measurements, observations about systems changes must still be offered with reservations. The reader should

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[1] The information on time preferences for listening developed in the New Era Survey indicate that this suggestion is of doubtful utility.

[2] The Statistical Pocket Book for Nepal, National Planning Commission Secretariat Central Bureau of Statistics, Kathmandu gives a figure for 1972 of 91,000 (p. 54). We find it difficult to reconcile a number this high with the figure of 1.2 million rupees (~ $120,000) per year on the average for imports of radios, transistors, record players, etc. (p. 101).

understand that our estimates of the costs of providing improved radio coverage may well be off by a factor of as much as two in either direction. This is mainly because of uncertainties about radio wave (ground wave) propagation characteristics in Nepal. Another factor is uncertainty in costs of transmitter equipment. For the latter we have used the figures given in Butman, Rathjens and Warren[1], p V-47, extrapolated where necessary to higher power levels, all doubled to reflect inflation and costs of spare parts, installation and transportation. Import duties and taxes are not considered (see section I-3). For antenna costs we have used a figure of $50,000 (see Butman, Rathjens and Warren, p II-18 for antenna tower cost as a function of height).

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[1]We should point out that our cost estimates are reasonably consistent with some others, but in other cases there are great differences. The consistency and inconsistency are illustrated by the following:

a) A 1 KW shortwave transmitter was purchased by Radio Nepal in 1973 for Rs 150,000 ($14,300), including accessories but excluding duty and transportation. Our estimate would be $13,000-$13,600.

b) The Fourth Plan of the National Planning Commission estimates costs for a regional broadcasting station in the western hills as follows:

transmitter and equipment	Rs 2,800,000	$267,000
land and buildings	250,000	24,000
miscellaneous construction	150,000	14,000
	Rs 3,200,000	$305,000

Assuming this to be a short wave station (and therefore requiring two antenna towers) with a power of 20 KW, our estimate would be $210,000. Some of the difference is to be explained as duty ($32,000). If the $305,000 includes studio facilities, that might account for another $10,000-20,000 of the difference, and if it includes an independent power supply that could account for most of the remaining difference.

c) Sahdev (p. 29) estimates the cost of a 100 KW short wave transmitter at $490,000, including accessories and transport but excluding duty. Our estimate would be $240,000-$270,000, a factor of two difference.

d) Sahdev (p. 30) estimates a cost for a complete 20 KW medium wave transmitter installation, with a directional antenna at $1,000,000, 1/2 of which would be for land, building and other local costs. He also gives a figure of $1,000,000 for a 50 KW station without a directional antenna (p. 31). Our estimates, not including some local costs (which we would, however, assume to be relatively low--see b, above) would be about 20% of his.

We can not reconcile our (and Nepalese) costs with Sahdev's estimates. If his are more realistic, costs in the later part of this section are low by a factor of at least two and perhaps by as much as a factor of four or five.

As noted above, Radio Nepal broadcasts on medium-wave from Kathmandu with a power of only 10 KW. This means that for most of the country outside the Kathmandu Valley radio reception will be somewhat erratic, depending as it must either on short wave transmission and/or on sky wave transmission in the medium wave band, the latter a possibility only at night. There is a further serious disadvantage in being dependent on short wave transmission, particularly for a country where per capita income is very low, because receivers, particularly multiband ones, will be more expensive than the medium-wave transistor sets now so widely available.

The situation is in sharp contrast to that in developed countries where in virtually all cases domestic broadcast coverage is achieved through a multiplicity of medium-wave (and in some cases, long-wave) transmitters. To cover large areas 50 and 100 kilowatt transmitters are commonly used and in some cases power levels are as high as 1.2 megawatts.

If it is judged to be in the Nepalese national interest to expand radio coverage, systems changes therefore seem indicated. Until recently the obvious direction in which to go would probably have been first to increase the power of medium-wave transmission from Kathmandu. However, with an east-west microwave communications link being completed from Bhairahawa to Bhadrapur (see Figure 1) it would be entirely realistic to use the link to distribute program material from Kathmandu to transmitters installed at several points along the link. The average cost of a voice channel for such distribution, or of several if higher fidelity transmission were desired, would be very small compared to other systems costs. More important, the decision already having been made to build the microwave system, the marginal cost of an additional channel, or channels for radio networking, would be substantially less than the average costs, and insignificant compared to other costs.[1]

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[1] One can calculate a marginal investment cost by estimating the cost of adding one RF channel to an existing system and then dividing that cost by the number of voice channels (~ 1000) that can be handled. If this is done, one gets a marginal cost of about $1 per mile. See Butman, Rathjens and Warren, op. cit., p II-34 and II-35; and for an extreme case of high costs, about twice that, Butman, Telecommunications Development in Indonesia, Table III. The Nepalese microwave system has a length of about 450 miles. The capital cost per added voice channel would then be $500 to $1000. But these figures are not really very meaningful. If one has capacity that is not being used, as will be the case in Nepal for some years the marginal cost for one additional voice channel will be very much less. At the other extreme, if it were necessary to add another RF channel just to get one additional voice channel the marginal cost would be very great.

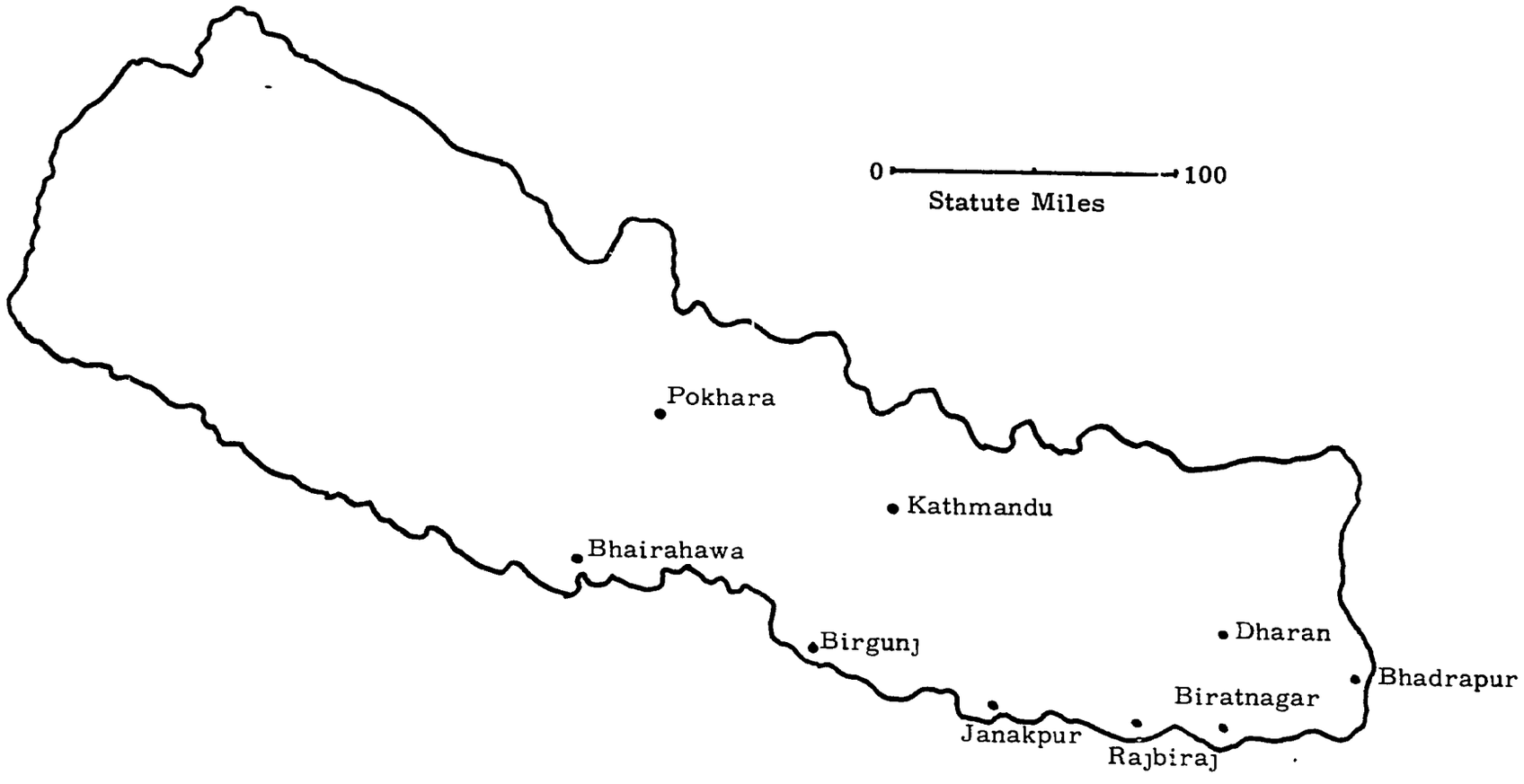

FIGURE '

NEPAL SHOWING CITIES TO BE SERVED BY MICROWAVE RELAY SYSTEM

The details of design of an improved system are beyond the scope of this paper and would depend on ground wave propogation characteristics and more accurate cost estimates. They will also depend on the fraction of the population to be reached and on priorities for reaching different parts of it. If reaching the largest number of people per dollar spent is the criterion for system improvement, and if reaching parts of the country remote from Kathmandu is not given priority, it may make sense simply to increase the power of the station in Kathmandu, notwithstanding the construction of the microwave system. On the other hand, if it is desired to reach a large fraction of the country outside Kathmandu it may be preferable to build transmitters at, say, Bhairahawa or Pokhara and at Rajbiraj, Dharan, or Biratnagar. Figure 2 shows the maximum fraction of the population that could be reached with high quality medium-wave transmission as a function of capital cost. It is assumed that the present 10 KW transmitter in Kathmandu provides adequate coverage over an area of about 5000 square miles.[1] As was noted earlier, costs may well be off by a factor of two. The curve is based on calculating coverage for a number of alternative systems expansion possibilities. For illustrative purposes five of these points are indicated on the figure and involve the following.

A) No change in the system.

B) No additional transmission sites but increasing power of the Kathmandu station to 100 KW.

C) No additional transmission sites but increasing power of the Kathmandu station to 500 KW.

D) No change in the Kathmandu station but adding a 20 KW transmitter at Rajbiraj linked to Kathmandu by microwave.

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[1] From the New Era survey, Tables 17, 18 and 19, it is clear that most respondents in the central hills (all in Sindhupalchok district) listened to medium wave broadcasts and reported clear reception at all times. From this we infer a primary service radius of 40 miles, a figure that may be conservative particularly in the light of an estimate of 50 miles by the Director of Radio Nepal. Use of a 50 mile estimate would reduce the power requirements on which figure 2 is based by 10% and the costs by even less than that.

E) No change in Kathmandu station but adding a 100 KW transmitter at Rajbiraj and a 100 KW transmitter at Bhairahawa, both linked to Kathmandu by microwave.

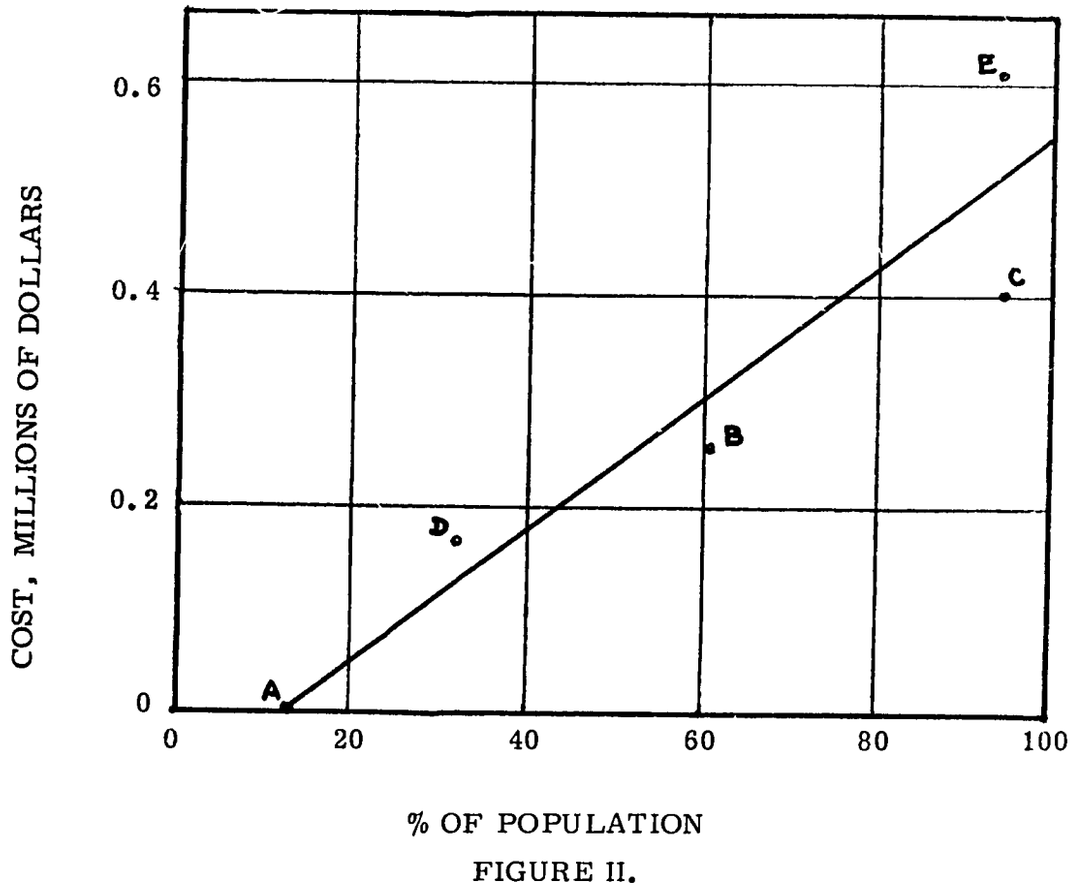

FIGURE II.

The figures do not include costs for additional studio facilities or power supplies. It may well be that if stations remote from Kathmandu were established, as in cases D and E, studios should also be provided to permit some local programming, including possibly in languages other than Nepali.

Systems changes of the kind we have hypothesized, and on which Figure 2 is based, are likely to have two significant effects. The reliability and quality of reception would be much improved, and the cost of receivers for many listeners would be less since they would not require multiband capability. With diminished cost, there would be an increase in sale of receivers. Although available data does not permit a precise estimate of the magnitude of the increase, the results of the New Era Survey make it possible to make some estimates which are suggestive of striking effects.

The survey indicated that one out of 18 households, i.e. 5.5%, had a radio, and that the average cost of a receiver (including taxes and duties) was Rs 668 or about $64. This corresponds to a before-tax cost of about $35. 3% of those not having radios indicated they could afford one at a cost of Rs 668. One concludes that 65%, i.e. ($\frac{5.5\%}{5.5\% + 3\%}$) of those who could afford a radio have one.[1] We now estimate how the development of a high quality medium wave broadcast system would affect the distribution of radios, and the duty and tax revenues from their sale.

With medium wave transmission, receivers half as expensive would likely be satisfactory.[2] Assuming, for the moment, taxation at the prevailing rate, the cost for a receiver would then be Rs 334. Some 22% of those not having radios who were queried by New Era indicated they could afford to buy a radio at that price.

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[1] This calculation is based on the assumption that in the New Era Survey the sample of non-radio owners was, like the sample of owners, limited largely to heads of households.

[2] Where signal strength is strong one would expect to see, as in the case of other developing countries, a proliferation of low quality $5 to $10 transistor sets, a possibility which we for the moment ignore.

If we apply the 65% ownership factor, calculated above, to the estimated increase in numbers of who can afford a radio at Rs 334, but who do not have one, i.e. 19% (22%-3%), we calculate an increase in ownership from 5.5% of households to about 18%--an increase of 260,000 radios. The duties and sales tax on this number of receivers would run about $3.6 million dollars, almost an order of magnitude higher than our cost estimates for near-100% medium-wave coverage. To the extent that even cheaper receivers would be purchased, the revenue per receiver would be reduced. However, the New Era figures suggest that the increase in sales would at least be offsetting. Considering the many tenuous assumptions involved, these calculations ought not to be taken too seriously, but they do suggest that the investment in a medium-wave radio transmission system could, in a sense, be self-liquidating.

3) Taxation

This brings us to the question of whether continuation of taxation on radio receivers (and other electronic equipment) at the present level is in the national interest. (Our understanding is that there is an import duty of 70% on radio receivers imported from India and 79% on those imported from elsewhere. On top of this, there is a purchase tax of 10%, and then an annual tax of Rs 10 (about $1 per year). We consider now the effect of a reduction in sales tax and duties, assuming no change in the broadcasting system and hence a continuing requirement for multiband receivers.

The New Era data and reasoning similar to that in the previous paragraphs leads to an estimate of an increase in ownership by 65% with a 50% reduction in the duty and tax rate. This suggests that there would be a modest (17%) loss in sales tax and duties, which, however, would be partially offset by an increase in use-tax revenues of $75,000 per year. This calculation is based on dubious assumptions so the conclusion is tentative but there is a suggestion that a reduction in the sales tax and duties on radios would cost the government little if

anything in revenues while achieving a wider distribution of receivers. If there is a feeling on the part of the government that increased proliferation of radios would be worthwhile, it would seem a small price to pay. In many developing countries there might be an important counter-argument: the desire to minimize imports in order to conserve hard currency. This argument would not apply in the case of Nepal--at least it would not have in the past--since the country has for some years had surpluses in its foreign exchange balance.

Needless to say, if both an expanded medium wave transmission service and a reduction in taxes and duties were implemented, the proliferation of radios would be greater than if either change alone occurred. We believe there is probably a very strong case for making both of these changes. In a society where transportation is very difficult and literacy and the availability of printed matter is low, it may well be that radio could be of great social importance, even aside from the possibility of its being used for formal educational purposes.

Depending on the availability of skills and concern about future expenditures of foreign exchange for imports, it may be of interest to consider the possibility of developing an industry to manufacture radios or components. But a decision to do so would also depend on scale, and it would seem unlikely that demand in Nepal even if stimulated by reduced taxes and improved broadcasting would be sufficient to justify an industry.[1]

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[1]The minimum output per model that might justify manufacture is apparently about 200 sets per day (Butman, Rathjens and Warren, op. cit. IV-15)--at least several times the current rate of imports.

II. Radio Broadcasting for Schools

It is our understanding that radio is presently being used on a limited experimental basis for education. There are four programs each of a 1/2 hour duration per week, one for teachers, two for adults and a fourth going directly to schools. Eighteen battery powered multiband radios (Sony 8R-12B/13B and 8R-12Y/13Y) provided by UNICEF have been installed in schools, all outside Kathmandu. Plans exist for expanding the system with 500 additional sets. The program has not been of sufficient duration for an evaluation of its effectiveness from a pedagogical perspective or in terms of its technical performance. After a year there appear to have been no maintainence problems, and batteries are reported to last one to two months. The radios are located near Pokhara and in the Terai. This means that they are located within about 100 miles of the transmitters at Kathmandu. Reception from 2 to 2:30 PM (the school broadcast) is reported to be of erratic quality. Programs for schools are now being broadcast for the fourth grade and it is proposed that additional grades be covered as the program is expanded. Feedback in the nature of letters and evaluation forms is reported to be favorable. We would make a number of observations about the present program and its proposed expansion.

1) In a country with only one radio station a question might be raised as to whether it is sensible to use 1/2 hour of air time per week to reach 18 radios in schools (presumably about 400 to 600 students), and indeed, questionable whether it is worth having radios in schools when the broadcast time is so limited. An alternative during the experimental period when software is being developed and evaluated might be to use tape recorders despite their greater complexity and maintainence problems. However, it

should be noted that Radio Nepal only broadcasts 85 hours per week so that there is obviously no great premium on air time, especially during daytime. The marginal costs of an additional 1/2 hour per week or of even a few hours, as would be required as the program expands, is therefore very small. Additionally, depending on their content, the programs aimed at schools may also be of interest to others. Thus, it probably makes sense to continue to broadcast, even during the experimental phase of this program unless there is a greatly increased demand for "air" time.

2) A decision to use radio in the schools will strengthen the case for improved medium-wave coverage (see part I). This will be primarily because of the greater reliability of reception, as compared with short-wave, especially important during daytime.[1] (The numbers of receivers involved will likely be sufficiently small that the cost savings made possible through better medium-wave coverage will not be very large.)

3) It is conceivable that ultimately the requirements for educational broadcasting will be so great that additional transmitting facilities will be required simply because of competition for air time. We question whether such construction should be undertaken prior to a careful evaluation of whether educational programs are worthwhile and until the need for such capacity is clearly evident. This is likely to be a long time coming. Those involved in educational broadcasting now hope for 8-9 hours per week 5 years from now.

4) <u>If</u> it is demonstrated that radio can be effective as an educational instrument in Nepal, there is probably a pretty good case for using it on a nation-wide scale in the schools. But the cost should be compared with other expenditures in the educational system. In the following we do this very approximately, using figures from The National Education System Plan for

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[1] Percentages of respondents to the New Era Survey who reported that reception was not good during day time were 29, 54, 94 and 81 for the western hills, the western Terai, the far western hills, and far western Terai respectively.

1971-76 (NESP), data relating to the operation of Radio Nepal and some other rough estimates.

a) First we compare the cost of providing radio coverage for all primary schools with teacher costs. We do this not because of belief that radio instruction can really be a very meaningful substitute for actual contact with teachers--it is more likely to be complementary--but to get some feel for whether it makes sense to consider adding radio in a school system where, at least in many cases, a case could be made for more teachers, considering the pupil teacher ratio. Cost of a radio for a school is likely to be $15 to $20 per year, including depreciation, maintainence, and batteries.[1] To this must be added costs of program development and transmission--perhaps $3 to $6 per school assuming the costs spread over 8,000 primary schools.[2] The total cost will then be of the order of $150,000 or $20 per school per year to be compared with salaries for primary school teachers of 155 rupees (about $15) per month. The teacher probably puts in somewhat more than 30 hours of classroom time per week. Assuming the radio is used 8, the cost per student hour is about one half as much for radio as for an additional teacher. This crude calculation suggests that it is neither ridiculous to consider the use of radio nor that it is obviously to be preferred to a greater investment in teachers. There may be a better case for the use of radio in the secondary schools, considering that teacher salaries are much higher, up to about $60 per month in secondary schools (but radio costs will also be somewhat higher because program development and transmission costs will have to be spread over many fewer students).

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[1] These estimates are based on the assumption that battery costs will not exceed $2 or $3 per year. Such a figure is consistent with radio usage of not more than 8 hours per week, selection of radios that have relatively low power requirements, and the use of standard D cell batteries at $0.20 each. It is very possible that radios would be used many more hours per week to listen to non-educational programs, and if this were to occur costs could be much higher. (The fact that batteries are being replaced every month or two suggests that this is happening with the sets now being used experimentally. If they were used only to listen to educational programs very much longer life would be expected.)

[2] These costs are based on the development of 80 hours of new programming material per year in the steady state and 8 hours broadcasting per week for 30 weeks per year. For estimates of programming and transmission costs see Present Costs of Educational Radio in Nepal, consulting report (draft) to U.S. AID by Dean Jamison.

b) It is of interest to compare the cost of radio with the cost of books. Using the figure above we estimate the cost of radio at perhaps $0.30 per year per student, based on 60 students per school. This is just about equal to the cost of operating the Janak Education Materials Center which prepares and prints all educational materials. To the Janak costs must be added those of distribution etc., but it will be clear that the costs of radio would be a substantial fraction of book costs; another comparison that suggests that there is no overwhelmingly obvious case for or against radio.

c) The hope has been expressed that radio used with correspondence lessons could be used for teacher training, reducing the need for attendance at training centers from 4 to 3 semesters. If it should be possible to do this without loss in effectiveness it would be highly desirable. The cost savings would be substantial. According to the NESP (p. 70) 3 million rupees per year are budgeted for teacher training, and presumably of the order of 20%, i.e. 600,000 rupees or $60,000 per year might be saved--perhaps 1/3 the cost of a system involving a radio in every school.

We conclude, not surprisingly, that whether or not radio should be used in the schools for education will depend critically on how effective it is as a teaching tool. It is too expensive to be bought unless there is a substantial pay-off; but not so expensive as to be priced out of the market if it is useful.

It is equally unclear whether public service programs, e.g. on family planning and improved agricultural practices, that are aimed at adults are, or could be, "cost-effective." As long as there are substantial off-the-air periods in Radio Nepal's schedule the marginal costs of such programs may be small: largely just production costs. But we would point out that such programs may be quite ineffective, and possibly even counterproductive, if they promote the use of contraceptives, pesticides, fertilizer, etc. that are not easily accessible to listeners. Making such materials available may be very expensive, so the radio part of the cost of an effective adult education

program based on radio may be a small part of the total. These points are considered in the New Era Survey.

Based on previous efforts, we are skeptical about the effectiveness of basing such programs on "village-type" receivers. Some years ago (~ 1960) a number of radios were distributed to Panchayats (villages) with such a program in mind, but it seems to have been unsuccessful. We were unable to determine what has happened to those sets, but some reports suggest that, not being privately owned, no one felt responsible for maintainence, and that many, if not most, are no longer operable. The other problem with such efforts has historically been difficulty in maintaining audience interest. This is in some contrast to the school situation where there is a captive audience, and experience has often been that attendance at adult education sessions based on village receivers falls off after the novelty has worn off. This suggests that if radio is to be used for adult education it ought not to be linked to the distribution of communal receivers or the establishment of "listening clubs".

III. Two-Way Communications

Until recently, telecommunications in Nepal outside of a few centers was almost entirely by short-wave radio. The system consists of 14 zonal offices and 75 district offices each equipped with a 100 watt transmitter. 18 of the 89 transmitters are operated on central a/c power. They have diesel generators as back-up power supply and such generators provide power for the others. Communication is almost entirely through Kathmandu on a time sharing basis with zonal transmitters on the air four to five hours per day and with the district offices on for about two hours per day. There are maintainence teams at each zonal office. The greatest difficulty is apparently with power supply.

As mentioned earlier a microwave system is being installed. It will be about 700 km long connecting Bhairahawa, Pokhara, Kathmandu, Birgunj, Janakpur, Rajbiraj, Biratnagar, Dharan and Bhadrapur (see Figure I). Initially it will carry only a few voice channels (12 to 24) but can easily be expanded to carry several hundred. Total cost will be about 2 million dollars.

In addition to the above there are some specialized communications systems, e.g. a military system and one for air operations.

The microwave system will improve the quality of service between those centers it connects and will open up the possibility of high capacity service (but it is hard to see demand for such service developing very rapidly). However, notwithstanding this, and other improvements that are being made, we believe that the national communications system is, and for some time will be, quite inadequate in terms of geographic coverage. There are places in Nepal that are as much as 50 kilometers by air from the nearest district transmitter, a number of days' walk. We can not but feel that a very substantial increase in two-way long distance telecommunications capability could be justified. It would be unrealistic to try to estimate all the benefits to be derived from such investment, but a case can be made for further investment by simply considering some of them.

We believe that health care could be a major beneficiary, particularly in the light of experience in other areas, e.g. Alaska, where travel is difficult and where there are large populations whose medical needs must be served by paramedical personnel. In considering this, it should be born in mind that health care system of Nepal is based largely on 251[1] health posts, manned by health aides. Some are quite remote from major centers where there are hospitals. For example, in the

[1]This figure is for 1972-73, Statistical Pocket Book, Nepal, p. 63. More are being established. The target is one post per 25,000 people in the Terai and one for every 8,000 to 10,000 in the hill and mountain areas. To meet these objectives will require about a three fold expansion in numbers of posts.

Pokhara region, some are 10 days' walk. There are only about 300 doctors in the country, and the majority of these are in the Kathmandu valley. Thus, there is no realistic possibility of most people getting routine medical attention from physicians. Doctors will optimally be located at hospital centers (of which there were 58 in 1972-73) where they can handle more serious cases (if the patient can be got to the hospital). Thus, Nepal would seem to be an ideal case of an area where two-way radio could be used to great advantage for the following:

a) to make possible consulting services between the paramedical personnel who man the country's health posts and physicians.

b) to expedite the delivery of medical supplies (even if delivery must be by foot, much time can be saved if orders are placed by radio rather than by messenger).

c) collection of reports on incidence of disease, e.g. epidemics, so that appropriate public health actions can be implemented.

d) to request transport to transfer seriously ill or injured people from remote areas to places where better treatment is possible.

To some extent there is colocation of health posts and communications centers, but obviously with 251 of the former and only 89 of the latter, most health posts will be dependent for communications on the physical transport of messages, mostly by foot. It would seem reasonable to consider locating a two-way radio at each health post, primarily for its use but also to provide other needed services. In those few places where electricity is available, it should be possible to do this for about $1500 per transmitter. In others, where a power supply must be provided the costs will be somewhat greater. Considering maintainence and depreciation, it is perhaps reasonable to use an average figure of $500 per year as an annual cost or about 25¢ per person served. There are problems with the proposal. The costs are not negligible compared to the other costs involved in establishing and maintaining health posts. (The

fourth five year plan had 16 million rupees, about $1.6 million, allocated to health posts with the number increasing from 33 to 225 during the period.[1]) The problem of power supply, including its maintainence, can not be lightly dismissed. It can be handled with motor-generator sets, but in that case there will be a problem in obtaining fuel. This suggests limiting the use of transmitters to matters of some urgency in areas where power is a problem. There are other possibilities for power, e.g. man-powered generators or storage batteries with charging being done with wind mills, or water power. Finally, the shortage of doctors seems so severe that there may be a question of their having time to consult with health aides by radio. Notwithstanding these problems, we believe a much expanded communication system for health care probably should be considered seriously particularly in the light of experience in other countries.

We were informed that consideration is being given to installation of equipment for two-way communications at some of those air fields that do not have them. It would seem reasonable to put such equipment at all of them. The problem of fuel for motor generator sets will not be severe as in the case of some health posts because it can be flown in if need be, and the savings to be derived in air operation would almost certainly pay quickly for the costs. Weather conditions during the monsoon period are such that many flights to hill and mountain areas have to be aborted, and the savings on such flights alone from improved communications would doubtless be substantial considering the costs of air operation. Presently the STOL aircraft charter rate is Rs 1300 (or $125) per hour and that for helicopters Rs 3925 ($370) per hour. In addition, better communications would make it possible to operate services under conditions where they are not now even attempted except on an emergency basis. Finally,

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[1] Fourth-Plan, National Planning Commission, Kathmandu 1970 (English translation 1972), p 248, 253.

having a transmitter at each airfield would provide the important capability of being able to communicate information about traffic demand for routine, and emergency, dispatching.

There are a host of other benefits that would follow from an improved long distance communications system. Any industrial or construction operations where maintainence or irregular consumption of supplies is a problem would benefit. Replacement parts could be ordered more quickly and authorization for expensive repairs, major changes in plans, etc. could be greatly expedited. The agricultural sector would benefit because, with more timely reporting of crop conditions, marketing and distribution could be more rational. In many countries demands of these kinds are met by those involved setting up their own two-way radio systems. This happens, for example, in oil exploration and other extractive industries and in transportation. (It happens, to an extent, of course, in Nepal in the case of the air line). But such developments do not obviate the need for improved public systems, and in a country like Nepal where the scale of most entrepreneural activity is likely to be small, an improved public system would seem to be especially important.

Up to this point our discussion of expanding two-way long haul communications has been based implicitly, and to some extent explicitly, on the proliteration of short-wave radio transceivers. Other alternatives should be mentioned, and then probably dismissed.

Extension of the microwave system, particularly to the west is a possibility. We would have doubt about the wisdom of this. Microwave systems will generally be cost-effective in those situations where the traffic level is high, i.e. where there is a demand for several hundred or more circuits between points and we see little likelihood of this developing soon in Nepal. In a country as little urbanized as Nepal such demand is likely to be realized only with a very extensive proliferation of telephone lines connecting rural

subscribers and villages to the centers served by the microwave system, and that may be a long time coming. This does not mean that the capacity of the system now being built will not be fully utilized. It may be, particularly if it carries government administrative traffic for which the telecommunications authorities are not fully reimbursed. And it may even be fully utilized if a rate schedule is developed such as to maximize revenues, for once built, it makes sense to have a schedule that will encourage use of the system. This does not mean, though, that the system will necessarily pay for itself, much less that an expansion of the system to serve more remote areas would. We suggest that the system ought not to be extended to the major centers to the west, at least until it is obvious that there will be a demand for several hundred channels, as demonstrated by operation of the system presently being built (where additional channels can be added at low cost). Other communications demands probably merit higher priority, e.g. low capacity services to really remote areas as discussed above.

An alternative to extending the microwave system or proliferating short-wave transmitters is communication via satellite. Unfortunately, none of the satellites now up, or being built, are, to the best of our knowledge, very well matched to Nepalese needs. However, the state of the art is developing in directions that may make satellite service a possibility for domestic communications for Nepal and other countries in a similar situation. The requirement is for low capacity at low cost. This can be met only if earth station costs are kept very low (of the order of $1,000 or less if such a system is to be competitive with short wave radio). The receiver component of the earth station can be kept that low--perhaps under $1000, if very narrow beams are used which permit power radiated from the satellite to be concentrated on area to be served. (For Nepal this is about 1 1/2° x 1/2° compared with beam widths of 4.5° for an Intelsat spot beam and 8° x 3° for Telesat).

The cost of the multiplexing for a few circuits, plus the up-link equipment, will, with existing equipment, be well in excess of $1000. Even for simple stations, several tens of thousands is a likely prospect.

Even with acceptably low cost earth stations, satellite sharing with other countries would be required to keep overall costs within reason, for it is clear that Nepalese demand will be small, and low costs per circuit can be achieved only with high capacity. This could conceivably be achieved by lease or otherwise sharing a satellite designed primarily for quite different purposes, particularly if a narrow spot beam could be available, or by sharing in a satellite designed for "thin-route" services. Very preliminary estimates suggest the economic feasibility of thelatter (there is no doubt about technical feasibility[1]) provided enough customers can be found.[2] The estimate ought not to be taken very seriously for our purposes considering the scale of activity envisaged in this proposal and the unlikelihood, or at least difficulty of developing a system of that scale. For this and other reasons, e.g., as indicated above, we are skeptical about the near-term availability of earth terminals at $1,000, we believe it is probably somewhat premature to count on satellite communications replacing short-wave radio as the preferred method for solving the point-to-point two-way communication problem for Nepal. Nevertheless, it may be time to give consideration, perhaps on the part of international aid agencies, to the possibility that satellites might serve Nepal's needs and those of countries with similar communications problems a few years hence.

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[1] If one uses a parabolic antenna on the spacecraft, using multiple feed to generate multiple beams, a maximum spread in beam angles would be about ± 5 beam widths. If one uses a parabolic antenna on the spacecraft, using multiple feeds to generate multiple beams, a maximum spread in beam angles would be about ± 5 beam widths. For a 0.5° x 1.5° beam, one could envision maximum coverage possibility of 15° x 5° with as many as 25 beam positions.

[2] R. P. Haviland has suggested a world system of four operational satellites which would provide between a quarter of a million and a half million circuits with the cost per call of about $0.07. TELECOMMUNICATIONS JOURNAL, Vol. 40, XVII/1973, p. 771.