

THE SURVEY OF INDIA SINCE THE SECOND WORLD WAR

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IN CONSIDERING a title for this paper my first thought was to call it "The Survey of India since the partition of India." Further reflection showed that this would be misleading; it would indicate that the big changes in policy in the employment and organization of the Survey of India were the result of the termination of British rule and the partition of India. In fact they were not, but have resulted far more from economic and world conditions arising since the war than from political changes in India itself. The partition of India and the termination of British rule altered the area of responsibility of the Survey of India and caused serious difficulties by the departure of experienced British officers; it did not however affect the general lines on which the Survey of India was working, except perhaps to increase potential demands for cadastral surveys from areas which had formerly been ruled by Indian princes. Of this I shall have more to say later.

The history of the Survey of India

Except just round the foreign settlements on the coast, no land surveys in the modern sense of the word had been made before the Franco-British wars of the Carnatic, in the days of Dupleix, and before the coming of Robert Clive to Bengal in the middle of the eighteenth century. The interior of India was then known only from travellers' tales. During the extension of British influence in the latter half of the eighteenth century British surveyors gave a good start to surveying by route traverses and astronomical fixings. These were mostly made by military officers marching with troops or on political missions. By the year 1800 political stability had been achieved in south India and this permitted the beginning of scientific survey work. Two great surveyors, William Lambton the geodesist, who in 1802 began the geodetic triangulation of India, and Colin Mackenzie who in 1815 became the first Surveyor General of the whole of India, laid the foundations on which the work of the Survey of India has since developed. Both were Army officers.

Mackenzie began systematic detailed surveys and aimed at completing one area and producing topographical maps on the 1-inch to a mile scale before moving on to the next. Revenue surveys on large scales were started in Bombay about 1812, and in Bengal some ten years later. These revenue surveys became of increasing importance and gradually developed into the elaborate field-by-field cadastral surveys that formed a distinct branch of the Surveyor General's department during the latter half of the nineteenth century. After Lambton's death, his work was carried on by George Everest,¹ who in 1830 started the Great Trigonometrical Survey of India in its modern form and attracted to its service the first of a succession of very able officers, mostly military engineers, who not only extended the principal triangles

¹ Whose name was subsequently given to the mountain.

throughout the length and breadth of the country but introduced and developed the important geodetic activities of high precision levelling and tidal, gravity and astronomical observations which have ever since remained important activities of the Survey.

In the interests of economy, every effort was made in the nineteenth century to draw general maps from the revenue surveys; purely topographical surveys were in general confined to the less inhabited portions of the country. As the revenue surveys made no attempt to indicate the topography of uncultivated land, and as there was no attempt to cover the whole of India with a continuous topographical survey, large areas were left blank or mapped in patches. The only continuous map was the $\frac{1}{4}$ -inch to a mile 'Atlas of India.' Soon after 1860 Thomas Montgomerie, who had been responsible for the survey of Kashmir, inaugurated the regular employment of special surveyors for trans-frontier exploration. These surveyors, often in disguise, penetrated northwards through the mountain barriers on the frontiers of India and brought back route surveys of Tibet and other little known lands beyond. In 1867 the Surveyor General's department, which was divided into trigonometrical, topographical and revenue branches, was officially designated the Survey of India.

Early in the twentieth century a strong demand was made, more especially by the army and the various engineering departments of the Government, for better maps. As a result a large increase had to be made in the establishment of the Survey of India, and to provide for the enormous amount of work required for the programme of new topographical surveys, it was reluctantly decided to throw responsibility for all revenue surveys on to the local or provincial governments. Looking back, this decision seems to many of us unfortunate; but the urgency for new topographical surveys was so great that something had to go. A new topographical survey was begun in 1905 with a view to covering India with contoured maps, published in colours, on the scale of 1-inch to a mile. The intention then was to complete this new survey in twenty-five years and to revise it at twenty-five-year intervals. A short time later it was decided that surveys on the scales of $\frac{1}{2}$ -inch or even $\frac{1}{4}$ -inch to a mile would be adequate in the less developed parts of the country.

From 1905 until 1939 the chief preoccupation of the Survey of India was the execution of this new programme of surveys and mapping. Shortage of money and the diversion of part of the resources of the department to other types of work delayed progress, which after 1939 virtually came to a standstill owing to the war. The result was that when India was partitioned in August 1947, about 180,000 square miles of what then became India, including Hyderabad, but excluding Kashmir, were not covered by modern style surveys; and about another 340,000 square miles were covered by modern style surveys more than twenty-five years old, many of them badly in need of revision. Since then Kashmir has acceded to India and the figures given above must be increased. By the end of the war it was also beginning to be felt that a larger scale than 1-inch to a mile was required for topographical maps in areas likely to be of commercial or strategic importance and a decision was made to provide $\frac{1}{25,000}$ scale topographical surveys in such areas. (Fig. 1.)

Towards the end of hostilities in the Second World War, it became evident

in India that, owing to the growth of population and the loss of Burma rice, increased agricultural production would be one of the main necessities of the country in future. This position was later aggravated by the loss of wheat, cotton and jute growing areas to Pakistan. As a result, a very large number of multi-purpose projects, some of which were new and some of which had been investigated before but pigeon-holed, came under active consideration. There was an immediate demand for surveys in connection with these projects and

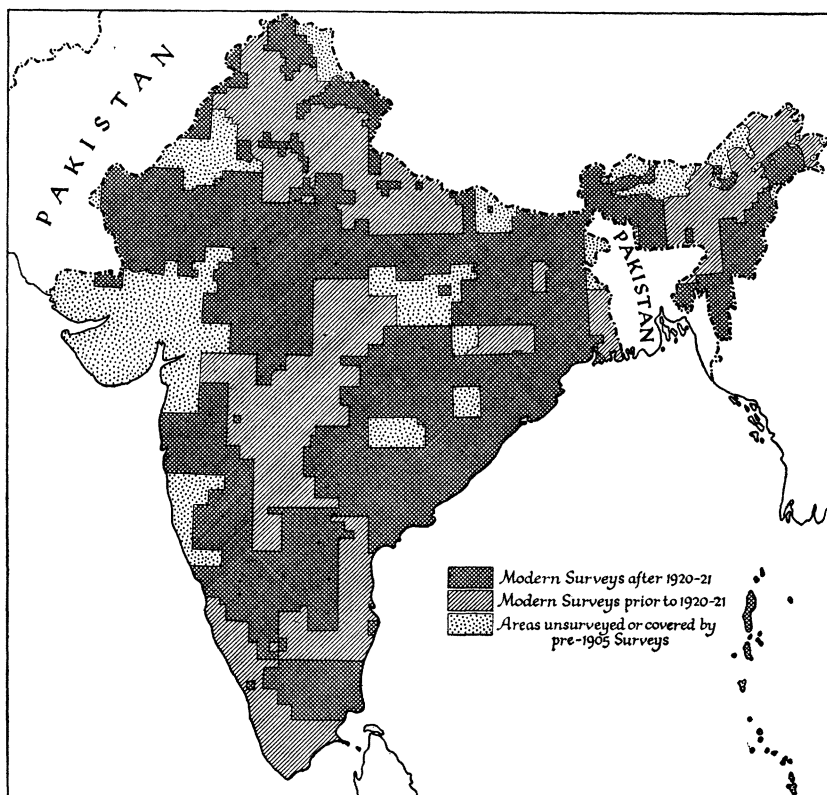


Fig. 1. The progress of topographical survey

this demand fell almost entirely on the Survey of India—as being the only organization with a staff capable of undertaking the work.

The close of the war and the subsequent partition of India gave a great stimulus to geodetic and geophysical work. This has largely taken the form of demands for high precision levelling to provide basic data for irrigation and power projects and for gravity surveys to assist exploration for oil by geophysical methods. There has also recently been renewed interest in tidal observations, the data on which tidal predictions are based being in many cases old and inadequate. The increase in civil aviation after the war also made it apparent that special aeronautical maps would soon be required, although for

a time this demand was met by the supply of maps prepared for the air forces during the war.

Summarizing what has been said above, the situation facing the Survey of India after the war was :

- (a) A very large area of the country was still not covered by the series of 1-inch contoured surveys which had been begun in 1905; and a demand was already making itself felt for topographical maps on a larger scale.
- (b) There were pressing demands (i) for surveys for multi-purpose projects, chiefly on the 4-inch to a mile scale with close contouring; (ii) for gravity surveys to provide a basic framework on which detailed investigations could be made by others; (iii) for high precision levelling to control the project surveys; and (iv) for new tidal observations and modern methods of tidal computation.
- (c) A new commitment had been undertaken for the production of special maps for Civil Aviation.

The cost of surveying since the war

At this point I must make a digression. The surveyor like most other people is largely governed in his methods and organization by economic considerations. In the past, one of the sources of justifiable pride of the Survey of India was in its plane-table surveyors. These men, who generally had little education, were recruited on very low pay and were equipped with very simple instruments. By rigorously eliminating unpromising pupils, a large body of plane-tablers was built up which carried out admirable topographical surveys, especially on small scales. Each plane-tabler had a squad of about five *khalasis* (survey labourers) to do chaining, carry instruments, etc., and who, before the war, were paid an average wage of about Rs.14 per month. The plane-tabler himself received on an average about Rs.70 a month. Local transport was also usually very cheap and easily procured. The result was that small scale topographical surveying by plane-table in India was very inexpensive.

The rise in the cost of living since the war and the introduction of the New Pay Code early in 1947 has completely altered the position. The plane-tabler who before the war cost Rs.70 now costs an average of Rs.130 per month, while the cost of keeping a *khalasi* in the field has jumped from Rs.14 to about Rs.75 per month. The cost of local transport has gone up in similar proportions. And, in common I believe with workers throughout the world, the plane-tabler is not prepared to work such long hours as he did in the past. The result of all this is that, far from being cheap, plane-table surveys now cost about four times what they did before the war, and we have been forced increasingly to turn to other methods.

Since 1925 the Survey of India had been using air photography for survey purposes. On the old North West Frontier its use was forced on us owing to the inaccessibility of the area to plane-table surveyors. Elsewhere the practice was to use graphical methods of plotting to obtain the outline of topographical features from the photographs, while contours were generally obtained by ground work. Here, too, we were taking advantage of cheap

labour; but as this is not now obtainable for survey work, India in common with most other countries will in future, so far as can be seen, carry out more and more of its work by air survey methods using automatic plotting instruments such as the Multiplex and Wild A-5 and A-6. For some years past the Government of India has had a contract with a firm which specializes in air survey and air photography for survey purposes to supply the department with the photographs it requires. The Survey of India has recently installed three tables of Multiplex plotting equipment, and hopes to install more plotting machines in the future. These should reduce costs by cutting down considerably the amount of ground work required and increasing the output per man.

Events at the partition of India

No account of the Survey of India in recent years would be complete without some reference to the events of 1947 when British rule terminated and India was partitioned.

For some months prior to the change which occurred on 15 August 1947, the shadow of great impending political changes affected all considerations of policy and planning. I remember listening to the radio with a group of others at the club one evening in June 1947 in Dehra Dun. The Prime Minister of India Mr. Jawaharlal Nehru, Mr. Jinnah for the Muslim community and Sardar Baldev Singh for the Sikhs all made speeches announcing their acceptance of the plan for the partition of India. Somebody remarked to me "It looks as though you will have to get moving pretty soon." This proved to be somewhat of an under-statement. Within a few days I received a telegram from the Government of India instructing me to put up detailed proposals, within what seemed a very inadequate time, for the complete partition of all assets, including personnel, of the Survey of India between India and Pakistan. We certainly had to act quickly, though our problems could have been no worse than those of other all-India departments.

We were fortunate in having a survey office established in Murree in the northern Punjab, in the area which is now Pakistan, and so had some nucleus on which to build there. As far as possible, all personnel opting for Pakistan were transferred before August 15, and so avoided moving during the period of maximum disturbance in northern India shortly afterwards. I think I am correct in saying that there was no loss of life amongst Survey of India personnel as the result of the communal riots following partition. In Delhi we had some anxious times with certain of our Muslim staff who did not wish to go to Pakistan. It became necessary to transfer them out of Delhi, and they asked to go to Calcutta which was then quiet. Their Hindu colleagues were very good in lending them clothes to disguise themselves; they were taken down to the station dressed as Hindus, complete with sacred cords, and were shepherded to an inconspicuous place in a third-class compartment in the train, where it was hoped their obvious agitation would not betray them. At the last minute, just as the train was about to leave, a party of formidable-looking bearded individuals armed with long swords entered their compartment to the great consternation of the disguised Muslims. Considerable apprehension was felt about the possible fate of our people after the train

started, but we were glad to receive a telegram a couple of days later announcing their safe arrival in Calcutta.

For the Survey of India, the effects of partition on personnel were for a time almost crippling. The majority of the British officers who were holding the senior posts left within six or seven months. Among the lower paid technical staff there was a very high proportion of Muslims, nearly all of whom went to Pakistan, and this left us with a great shortage of plane-tableers, traversers, draftsmen and map reproduction technicians. We found ourselves for a time quite unable to meet the majority of demands made for surveys. In August 1946, just a year before partition, the Government had sanctioned a considerable increase in the establishment of the Survey of India in view of the increased demands for its services. The loss of our British and Muslim personnel made our establishments look very empty. A recruiting programme was undertaken but this had the effect of accentuating the shortage for a time, by removing some of our more skilled remaining personnel as instructors.

After a short period of uncertainty the Government of India agreed that the pre-partition establishments should, with one or two unimportant modifications, apply to the India remaining after partition. This was in effect a second increase in the establishment of the Survey since the war, as the area now to be covered was considerably smaller than it had been. The effect of this double expansion, combined with the loss of senior officers, resulted in the promotion of officers to senior positions which a few years previously they could never in their wildest dreams have aspired to occupy. In those very disorganized times due consideration could not, unfortunately, always be given to merit, and not all those promoted have proved themselves worthy. The most remarkable feature of this rapid promotion has however been its illustration of the adaptability to responsibility of many individuals. It would be incorrect to say that there have been no lapses from proper standards of technical or administrative efficiency, yet the results of these promotions have certainly been much better than most people expected. More recently the Government of India has enforced a policy of rigid selection of those best qualified for promotion, without undue regard to seniority, and this has given openings for many very promising junior officers. By the end of 1948 the corner had been turned and the efficiency of the Survey was definitely improving.

The composition of the Survey of India

Before the war the majority of executive officers (those in charge of field Survey Parties, Drawing Offices, etc.) and the higher administrative officers, were commissioned officers of the Royal Engineers. These constituted the Class I Service; below this was a service of junior gazetted officers recruited in India from college graduates; this was the Class II Service. Below this again were Upper and Lower Subordinate Services of technicians. The former were recruited from those with educational qualifications of not less than Intermediate standard; the latter had no particular educational qualifications and comprised the bulk of the plane-tableers, traversers, levellers and other field staff.

An interesting development has been the attitude of the independent Government of India towards the employment of regular military officers of

the Corps of Engineers in the Survey of India. For some time before the termination of British rule there had been a tendency in certain government quarters to deprecate the employment of military officers in civil departments such as the Survey of India; and shortly before partition it was decided that the composition of the Class I service would be 37½ per cent. military officers, 37½ per cent. directly recruited civilian officers, and 25 per cent. officers promoted from lower services. Since partition however, the armed forces have shown an increasing interest in the Survey of India and it has now been decided that the Surveyor General of India shall always be a military officer and that 50 per cent. of the Class I service shall in future be recruited from military officers, at the expense of the quota of directly recruited civilians. It has also been decided to keep a Military Survey Service in existence in peace time.

Before the war the Survey of India was responsible for military survey preparations, the link with the Army being a staff captain at Army Headquarters in the Military Intelligence Branch of the General Staff. The new Military Survey Service is very small and has inadequate personnel to carry out more than a limited amount of technical work, and such staff duties as the Army requires in peace time. The bulk of military survey and mapping requirements are therefore still met by the Survey of India. To secure coordination and make the best use of the limited resources available, the Surveyor-General of India is, in peace time, also the Director of the Military Survey Service. Under him on the military side is a military staff paid entirely by the Army. In order to provide the Military Survey Service with trained survey officers the Survey of India will arrange to post back its military officers periodically for tours of duty with the Military Survey Service.

The spelling of geographical names

One of the responsibilities of the Survey of India is for the spellings of geographical names; and during the last few years this has been a constant source of concern. In the days of British rule the *Gazetteer of India* was the authority for the spelling of all names appearing in it, and it was the responsibility of the Surveyor-General to bring to the notice of the authorities the need for any changes in *Gazetteer* spellings. If a name did not appear in the *Gazetteer of India* the authoritative spelling was that appearing on a modern Survey of India map. The normal way of obtaining this spelling was to get the best version of the name spelt in the local script, obtain the concurrence of the local civil authorities and then to transliterate this into Roman script according to the recognized system of transliteration. This was all right for names written in the Urdu or Devanagri scripts used in northern India. A weakness of the system was that there were no standardized systems of transliteration applicable to some Indian languages, especially those of southern India such as Malayalam, Telugu and Tamil. As English was very largely used in southern India the usual practice was to apply to the Provincial authorities, ask them for the spelling in Roman characters and accept that.

Another difficulty has arisen from the fact that when the Hunterian system of transliteration was adopted in about the 1880's certain well-known geographical names were allowed to remain unchanged, although it was recog-

nized that they were not correct transliterations of the spellings in the local script. Examples are the names Ganges, Delhi and Cawnpore, which if correctly transliterated should be Ganga, Dehli (from the Urdu) and Kanpur respectively.

Under the newly approved Indian Constitution the aim is to adopt Hindi, written in the Devanagri script, as the national language of India in fifteen years. It seems certain however that, for some time at least after that, it will still be necessary for the Survey of India to produce editions of the maps of India in the Roman script. From the time of the adoption of Devanagri as the national script, the authoritative spelling for any Indian geographical name will be the Devanagri version of it, and the Roman version will be this name transliterated into Roman characters according to the recognized system of transliteration. As we have just seen however, there is no recognized system of transliteration into Roman of many Indian scripts; still less are there recognized systems for transliterating all the Indian scripts into Devanagri. Until these systems of transliteration are agreed on, any attempt to change names in Roman script now might merely result in the name having to be changed again on the adoption of Hindi as the national language.

In view of this, and of the seriousness of changing a name already well known throughout the world, the Central Government in India has been very cautious about adopting any changed spellings of names. Unfortunately the Provincial (now State) governments have been by no means so cautious, and shortly after partition some of them set about issuing revised spellings of many names in their territories without apparently recognizing the difficulties that might be involved, or without consulting the Surveyor-General. Certain Central Government departments, such as Posts and Telegraphs, followed suit. Had these changes in spelling been merely to correct obvious errors in such existing spellings as Cawnpore for Kanpur, not much harm would have been done. Unfortunately, some of the revised spellings are just as wrong as those they sought to correct; and many of them are not even consistent among themselves. For example, many southern Indian names terminate in what the British spelt "patam," such as Vizagapatam and Seringapatam. This word should really be "patnam" (meaning "town"). In the revised spellings issued by the State government this is variously rendered "patnam", "patnam" and "patinam" and, in the absence of standardized systems of spelling and transliteration, it is impossible to say which is correct; all one can say is that all three can hardly be right.

Central Government departments have now agreed not to alter further names or adopt new spellings without consulting the Surveyor-General, and so have all the State governments with one exception; so it is to be hoped that before long something will be done to systematize spellings. I think it fairly certain that some of the changed names, such as Kanpur, will be adopted but I would not like to hazard a guess about the future spelling of names such as Delhi.

Survey work carried out since the war

I now propose to give a brief account of the survey work carried out since the war. I include some details of the project surveys as the scope of the

projects may be of interest. The main survey work on which the Survey of India has been engaged can be conveniently divided into the following classes: (a) Regular topographical surveys for standard Survey of India map series on the 1/25,000 and 1-inch to a mile scales; (b) geodetic and geophysical survey work; (c) project surveys; (d) cadastral surveys; and (e) training. I give below some account of each of these classes of work.

Regular topographical surveys. Owing to the urgency of demands for other work, little progress has been made since the war in the completion of the programme of topographical surveys begun in 1905. A few thousand square miles have been surveyed in Bombay State where the existing maps were from uncounted surveys upwards of seventy years old. A beginning has also been made on the 1/25,000 series in Kutch, in connection with the new port of Kandla.

Geodetic and geophysical surveys—geodetic triangulation. The whole topographical survey programme of the Survey of India is based on the network of geodetic triangulation largely completed in the last century. Many of the stations of this triangulation were on brick towers which have since fallen down. Other stations have been lost; and there is now a definite danger that sections of this geodetic framework may be completely lost. We were fortunate in getting a set of Bilby portable steel towers from American disposals shortly after the war; I have often wondered just why the American forces brought these Bilby towers to India, as they certainly never used them there, but I am very glad that they did. The towers were tried out on the triangulation in connection with the fixation of the East and West Bengal boundary astride the Ganges, where they have proved a success. We shall also use them largely in connection with the rehabilitation and strengthening of the geodetic triangulation framework; it is hoped to begin a regular programme in the near future. Since the war we have re-observed and strengthened some geodetic triangulation in Kutch where it was urgently needed in connection with surveys for the new port of Kandla. We have also begun a new geodetic series which will cover the Andaman Islands. This work, which should have been finished early in 1952, had to be discontinued in 1951. It is interesting to note that precise observations for latitude and longitude in the seasons 1950-51 have resulted in a correction of +30" to the previously accepted longitude of Chatham Island, the datum station for the latitude and longitude of the Andaman Islands. The extension of the high precision level net has made some progress and has been given considerable stimulus by the demand for levelling for irrigation projects.

Tidal observations. The demand during the last few years for the development of the Indian Navy and mercantile marine has focussed attention on the need for improved tidal predictions for Indian ports. The Survey of India has been making tide predictions for many years for many of the ports on the Asian shores of the Indian Ocean, but the observations on which predictions are made are generally old, and were often somewhat inadequate in the first place.

We are now installing a number of automatic tide gauges at the more important ports. A field party has also been employed for the last couple of seasons doing twenty-nine-day observations at numerous new ports, and this

will enable tide tables to be prepared for them also. Our tide predicting officer was sent to the Tidal Observatory at Liverpool in 1949 for a course in the latest methods of prediction; and we have accepted the view of the Director of the Liverpool Tidal Observatory that our present tide predicting machine, which has been in use since 1888, is inadequate. We have accordingly ordered a new machine with forty-two components and hope it will be ready for use this year.

Magnetic survey. We had hoped to resume work on magnetic observations, but unfortunately funds have not permitted the establishment of a new magnetic observatory near Dehra Dun in place of our old one which was rendered useless by the encroachment of buildings and electric power lines.

Gravity observations. As I have already noted briefly, gravity observations have received a great impetus since the war as there is a strong desire on the part of the Government of India to exploit oil and mineral resources to the full. A couple of years ago we purchased a modern gravimeter and have been carrying out observations in areas which the geologists consider promising for mineral prospecting. The function of the Survey of India in this work is to provide a network of gravity stations throughout India which can be used by geologists and others engaged in mineral and oil prospecting, as bases for their detailed work in particular areas. We hope to purchase in the not too distant future a gravimeter of another type which it is felt may be more satisfactory for the particular type of work we require.

Project surveys. I have referred above to the great demand for project surveys and the location of the principal surveys we have undertaken in this connection is shown in Figure 2. The most common type of project is for a combination of purposes, such as the generation of hydro-electric power, irrigation, flood control and soil conservation. The normal scheme of such projects is for the erection of a dam in a river gorge and the use of the impounded water for irrigation and the production of electric power. In the preliminary investigations, the work required of the surveyor is to outline the area that will be flooded if a dam is made at a selected location and of a given height. Contoured maps or contoured air photo-mosaics are therefore required to enable the engineers to estimate the volume of impounded water. A large-scale survey, generally on a scale of about 1/2400, is also required of the dam site. The third and much the largest task is to survey the area to be irrigated. Generally maps of the commanded area are required on a scale of 4 inches to the mile, with contours at 1- or 5-foot intervals; and a large number of bench marks have to be sited at regular intervals on the ground. The object of these maps and surveys is to enable the engineers to make a preliminary siting of their canals and distributaries on the map, and to do the final layout on the ground.

The main surveys of this kind that we have carried out recently have been in connection with the following projects:

(1) *The Mahanadi project*, near Sambalpur in Orissa. This whole project envisages the construction of three dams at Hirakud, Tikkapara and Naraj. The first named has priority and the survey work is complete, and work has already begun on the construction of the dam. The objects of this project are flood control in the Mahanadi delta, the generation of electric power, the

irrigation of about 900,000 acres, and an improvement in navigability of the Mahanadi river itself. I understand that the work on the Hirakud portion of the project is scheduled to be complete within five years.

It is interesting that there was much local opposition to this scheme, not only as might have been expected from those who would lose their lands and homes through flooding by the reservoir, but also by those whose lands would be irrigated. Their argument was that their taxation would go up, they would have to work harder to pay it, and would in many cases have to

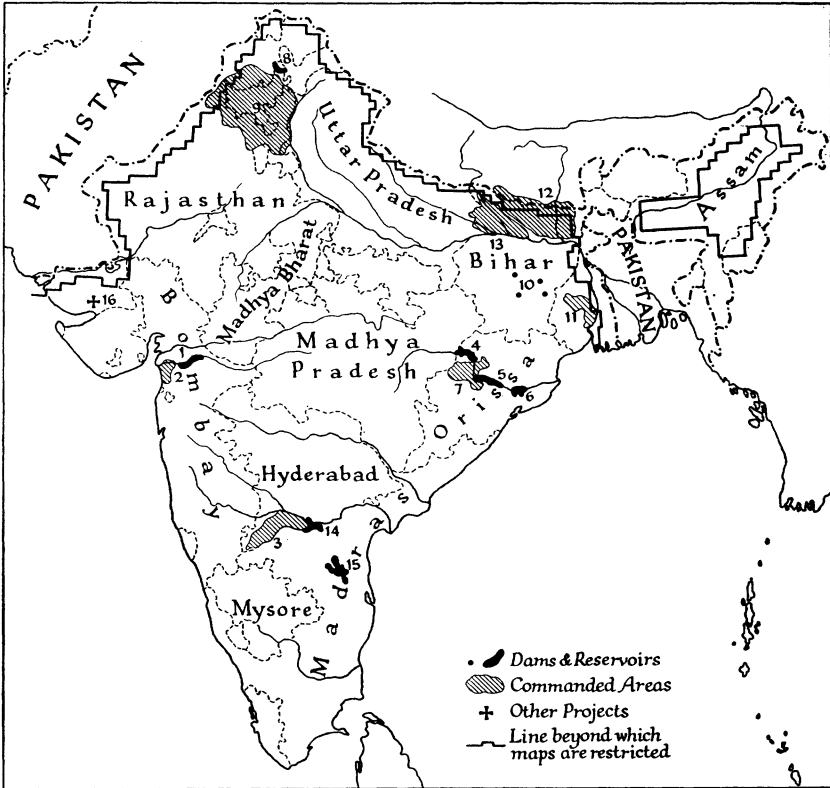


Fig. 2. Project surveys ¹

grow two crops in a year where one had previously been enough for their needs. The opposition took the form of removing bench marks, and in some areas about a quarter of the bench marks set up in one year were found to have been removed when work was resumed the next year.

¹ The projects numbered in Figure 2 are the following: 1. Kakarpara dam and reservoir; 2. Kakarpara commanded area; 3. Tungabhadra commanded area; 4. Hirakud dam and reservoir; 5. Tikkarpara dam and reservoir; 6. Naraj dam and reservoir; 7. Hirakud commanded area; 8. Bhakra-Nagal dam and reservoir; 9. Bhakra commanded area; 10. Damodar valley; 11. Damodar valley commanded area; 12. Kosi commanded area; 13. Gandak Barrage commanded area; 14. Kistna dam and reservoir; 15. Pennar dam and reservoir; 16. Kandla port development.

(2) *The Kosi project.* This relates to the construction of a very high dam in the gorge where the river Kosi leaves the hills in Nepal. The proposed dam is to have a height of about 780 feet, which I think would make it the highest dam in the world, and the main purpose of the scheme is flood control of the Kosi (Bihar's Yellow River) which floods annually, and frequently causes untold devastation in the plains of Bihar by changing its course. In addition to the high dam, a barrage is to be constructed a few miles lower down. Survey work on this project was stopped in August 1950 and I am not sure when construction work will begin. The dam would be uncomfortably close to the epicentre of the very severe Bihar earthquake of 1934 and the rate of silting would also be likely to cause difficulty.

(3) *The Bhakra-Nangal project.* This envisages a dam about 680 feet high across the river Sutlej in the Punjab, near the point where it leaves the hills, and another dam at Nangal about 8 miles downstream. Survey work on the areas to be irrigated by this scheme has been going on intermittently for many years but has recently assumed very high priority; work on the Nangal dam is already under way. From this an extensive canal system will take off and eventually, should the whole scheme come to fruition, large quantities of electrical power will be available as far afield as Delhi; the irrigation will transform arid areas like Hissar district in the East Punjab, which suffer from chronic shortage of rainfall and periodic famines.

As most of the area which will be served by the Bhakra project is not fully cultivated, the main task of the surveyor is to divide this land into rectangles of 3000, 100 and 25 acres respectively. At the corners of these rectangles stones are embedded, the heights of which are fixed by levelling. The survey work thus serves the double purpose of dividing the land into a system of rectangular plots and covering it with a close network of bench marks. It is anticipated that power will be available from this project by 1952 and that 6.6 million acres of land will be irrigated, 1.6 million acres of which are now waste land. The whole scheme is scheduled to be completed by 1955-56.

(4) *The Damodar Valley project.* This was originally intended for flood control but now has developed into a multi-purpose project envisaging several storage dams with hydro-electric plant in the valley of the Damodar. Some of the first surveys for this project were done at the end of the war by a military survey unit largely manned by Survey of India personnel awaiting demobilization. Recently, surveys of the area to be irrigated have been undertaken on contract by a private firm specializing in air survey and the Survey of India is also taking up some of the work.

(5) *The Tungabhadra project.* This is a joint enterprise by Madras and Hyderabad and will result in the irrigation of about 300,000 acres in the State of Madras and another 670,000 acres in Hyderabad State; in addition a large amount of electrical power will be generated. The Survey of India has carried out surveys of a very large area in the State of Hyderabad and it is hoped that the whole scheme will be complete by 1954.

I have mentioned a few of the main undertakings, but the Survey of India has also worked since the war on numerous other projects of which the more important are the Tista project (which was abandoned after the partition of Bengal), the Gandak project which will irrigate large areas in Bihar, and

the Kakrapar project on the river Tapti in Bombay. A project of a different kind which deserves some mention is the development of the port of Kandla at the eastern end of the Gulf of Kutch. Considerable survey work was required and surveys of the Rann of Kutch are now being asked for in connection with the exploitation of ground water in the region.

Cadastral surveys

I noted towards the beginning of this paper that after the reorganization of the Survey of India in 1905 the responsibility for cadastral surveys passed entirely to the Provincial governments. Speaking as a surveyor I do not think that the result was a success, though it may have been inevitable in the circumstances of the time. The consequence has been that little was done by the provinces after 1905 to establish or preserve the survey marks which could have been used as starting points for fresh surveys. The staffs of Provincial survey departments are often unqualified for anything but the most rough and ready surveys and much of their work would not stand up to examination. So far this state of things has caused little serious harm, though on occasions it has led to much expense. For instance, in the fixing of the disputed portions of the boundary between East and West Bengal we had to discard any attempt to use provincial survey data for the framework on which the boundary was to be fixed, and had to go back to the geodetic triangulation stations. Some of the new State governments are however beginning to realize the need for more attention to accurate survey work and are tending to turn to the Survey of India for advice and assistance.

Many of the former princely States, which have now been either consolidated or merged into the former Provinces, had no proper land-revenue settlements; and so have very large cadastral survey tasks in front of them and no adequate survey staffs to carry them out. The Survey of India has been so short of staff itself since the war that it has not been able to render the help required, but its advice is frequently sought; and all States, with one or two exceptions, have accepted the regional Directors of the Survey of India to be their advisers on survey matters. It is hoped that as the officer situation eases in the Survey of India it will be possible to second officers to the States to assist them with their survey problems. A beginning has been made with the State of West Bengal, to which we have lent a Survey Officer who continues to work under the technical direction of the local regional Director of the Survey of India.

Training

Prior to the partition of India, the training of surveyors was carried out in the Abbottabad area in the North West Frontier Province as this had a climate which enabled field work to be carried on for practically the whole year. After partition the training of plane-tablers was moved to the Bangalore area, where the country is suitable for most types of survey work and the climate permits of outdoor work for most of the year.

The training of officers is now carried out under the orders of the Director, Geodetic and Training Circle, at Dehra Dun. All Class I and Class II officers go through a very complete course of training on joining and have,

at the end of it, to sit for an examination of the standard of the Intermediate Examination of the Institution of Surveyors (India). For those who pass, courses are held at Dehra Dun during the summer to prepare them for the final examination of the Institution of Surveyors. By thus insisting on a thorough theoretical and practical training at the outset of their careers it is hoped to raise the general technical standards of officers.

Trans-frontier exploration

For the last century and a half surveyors and explorers based on India have played a very large part in central Asian exploration. The area north of India has long provided the adventurous with a field for exploration and with the opportunity for filling important blanks on the map. Non-official explorers and travellers could count on the support and assistance of the Survey of India. Though their governments did not encourage strangers, the countries immediately north of what is now India were not regarded as potential routes of approach for an aggressor and few or no restrictions were put on the publication of maps covering the northern Indian frontiers and beyond, from Kashmir in the west to Assam in the east, and any new information about these areas was made public.

Now the situation has changed. Faced with uncertain political conditions in the countries to the north, the Government of India has been obliged to restrict all maps on topographical scales which cover the northern frontiers and beyond. (See Fig. 2.) Such maps will not be available, as in the past, just for the asking nor will it be possible for the explorer beyond the northern borders to publish his results for the information of all the world. It is a sad thought that the days of trans-frontier exploration of the Survey of India are gone; but in a rapidly changing Asia it seems inevitable that it should be so.

No paper of this sort would be complete without some reference to the future of the Survey of India. We have keen and promising young officers coming on, and there is no doubt that the Government of India increasingly appreciates the work of the Department. Given good and progressive leadership and enough money, there seems to be no reason why the Survey of India should not maintain its position as one of the great survey departments of the world, and continue its contributions to science.

DISCUSSION

Afternoon Meeting, 11 February 1952

The CHAIRMAN (Brigadier M. HOTINE) said: For the benefit of those who have not yet heard of Brigadier Heaney I should like to say that he has recently retired from the post of Surveyor-General of India and that he is going to speak to us on the work of his department since the Second World War. His work covered the difficult period following the partition of India, so that he had to reorientate the work of the department over that period.

Brigadier Heaney then read his paper

Brigadier SIR CLINTON LEWIS: As an old member of the Survey of India I have been much looking forward to Brigadier Heaney's paper. He has told us

of the problems of the hand-over but has left us to infer his own personal difficulties as first head of the Department under the new regime; I know they have been considerable. He has told us about the current work and the special surveys which have been undertaken since the war. I should like to say a word or two of the old days, the heyday of the programme of regular topographical survey.

India has perhaps more variety of country than any area in the world of comparable size. I spent my first field seasons down in the far south, in the then unexplored forests of Travancore. We were surveying the catchment area of the Periyar dam where the elephant grass was 10 feet high and, quite unaccountably, one might find oneself in the middle of a herd of elephants a hundred strong or more. The natural reaction was to make for the nearest tree, not that that was much good because anything small enough to climb was small enough for an elephant to knock over. Elephants in the herd are however docile and move off when one makes enough noise. In the forests the trees were so high that pigeons on the topmost branches were out of gun-shot range—or I should say, out of my gun-shot range.

At that time Burma was part of the Indian Empire and we surveyed the Irrawaddy delta, where the jungle is probably as impenetrable as anywhere in the world. Fortunately we did not have to penetrate it, as we did the survey from the air. Quite different again was the Indian desert, the shifting sand dunes of Bikaner and Jaisalmer; in some places the wells were over 400 feet deep. The biggest contrast of all is of course in the Himalaya, the Karakoram and the Hindu Kush, about which we have heard so often in this hall. Between the wars, regular surveys were undertaken in Chitral, Garhwal, Kumaon and Sikkim. This led to the training of a selected band of Indian surveyors, not only in high mountain plane-tabling, but also in the craft of the climber and, as we have been told, many of our surveyors accompanied private expeditions to the mutual advantage of the Department and the explorers. We now learn that much of the northern frontier region is unfortunately closed for reasons of security.

We had a great regard for the Indian plane-tabler, and indeed for all the Indian personnel of the Survey of India; I think the *khalasis* of those days were tougher than now. When we were in camp, some of them would be sent out once a month with the surveyors' mail and pay packets and they would think nothing of covering 200 miles in three or four days; 50 or 60 miles a day at a steady jog-trot through the night with a few hours' rest in the middle of the day, taking their meals from the wayside villagers. In those days government messengers could demand meals from villagers as an immemorial right. Nowadays they usually proceed by country 'bus. Then there was the *tindal*, the headman of the *khalasis*, one of whose jobs was to run the check lines. He would be shown a distant point, a prominent tree or hillock 3 or 4 miles away, to which he was to run his chain. The terminal point was out of sight half the time, but he would keep a perfectly straight line and laboriously record in his notebook the points at which it crossed roads, streams and so on. When at the end you checked the work, he made a point of giving all the distances from memory and never referred to the notebook unless some discrepancy in the surveyor's work came to light.

The Indian surveyor had a great sense of loyalty. In the areas we surveyed there might be many hundreds of square miles of dense forest and it would have been easy to "fake" the remoter parts; he would know that an inspecting officer could not go everywhere, especially where communications were almost non-existent. In high mountains it would have been much easier to sketch in

what he could see and guess what was round the corner, rather than climb a high peak or a difficult glacier. Yet, by and large, there were few lapses of that kind. We tried to build up a tradition of integrity and I hope and believe that the Government of India will uphold and foster that tradition in the future. That goes for Pakistan also.

Professor KENNETH MASON: I have enjoyed Brigadier Heaney's lecture very much indeed. It is twenty years since I left the Survey of India and I was there for twenty odd years before that. Much of my service was, under a kindly Government with kindly Surveyors-General, in the disputed part of Kashmir which is one of the most pleasant countries in the world to survey. I spent seven years there and I have travelled in the eastern Himalaya also.

I should like to make one or two points, not so much on the survey side because it is not the Surveyor-General's Department which is concerned; I have in mind the danger inherent in some of the big schemes in the eastern part of India and the Ganges plain. One great danger is that of trying to harness the waters of such a river as the Tista, which has changed its lower course half a dozen times in four hundred years, at one time flowing into the Brahmaputra, at another time into the Ganges. I hope the engineers in India realize the great changes that will take place when they try to control a river of that type. Flood and scour are immense forces with rivers having a Himalayan and monsoon regime. I have also in mind the Ganges itself; its lower course, too, has changed considerably during the last four hundred years. In early Tudor times it came down the Hoogly past the present site of Calcutta. It is, I believe, only since 1787 that it has taken approximately its present course.

Then there are the engineering projects for the rivers of eastern Nepal. Why put up enormous "Boulder Dams" on those rivers in an unstable earthquake zone? There are two or three big thrust planes in the outer Himalaya here and, it is believed, a new boundary fault. I should have thought it most dangerous to build high dams in that area. The annual rainfall at Darjeeling is 122 inches a year, of which over 100 falls in three months. In the catchment of the Kosi there must be an average of 80 inches of rain falling in the three months when glaciers are still melting; I cannot conceive how all this water is to be controlled behind a dam. Fortunately it will not be the Surveyor-General's business if the dam gives way. Nor can I really see why there is any need for a project of this kind at Damodar; I believe Brigadier Heaney said that it was for the purpose of draining and controlling the water rather than for irrigation.

Brigadier HEANEY: It was originally a control scheme but the present Government have enlarged its scope to cover power and irrigation.

Professor MASON: Why irrigation? In the eastern plains of northern India the endeavour is always to get water off the land because there is too much; in the north-western plains water has to be conserved because there is too little. There does not seem to be much object in spending vast sums of money in that connection.

I do congratulate the Survey of India on maintaining their manifold activities, tidal, magnetic and so on, all just as before, and I also congratulate the Surveyor-General on having made such a magnificent job of it.

Mrs. HALEY: Will the Colombo Plan, inaugurated by the United Nations, finance any of these projects in India as a part of South-east Asia?

Brigadier HEANEY: That is a little out of my province. I understand however that the Government of India is obtaining funds from the World Bank for some of the projects. I do not think that the Colombo Plan has got to the extent of allocating funds for definite projects but I imagine that the Government of India will ask for funds in due course.

Mr. C. PAPE: Has the Survey of India moved its headquarters to Hathibarkala or is it going to do so?

Brigadier HEANEY: The Surveyor-General's headquarters, comprising the purely administrative offices of the Department, were in Delhi from 1941 until 1950, when they were moved to Mussooree. They have now moved down to Dehra Dun and are situated in the old Geodetic Branch compound and not in the Hathibarkala estate.

Mrs. SHAW: It was not clear from what the Surveyor-General said whether the senior officers of the Survey of India were recruited from the British or the Indian Army.

Brigadier HEANEY: For many years the system of recruitment was to take three officers from the Royal Engineers (who are British Service) and one British officer from the Indian Army. Between the two wars, when it was desirable to Indianize as much as possible, the recruitment of Indian instead of British officers from the Indian Army was begun; when the Corps of Indian Engineers was formed, the recruitment of Indian officers was confined to that Corps. The result was that when the last war broke out the majority of military officers in the Survey of India were Royal Engineers, there were also a few British officers from the Indian Army; we also had two Indian officers from the Indian infantry. It was soon after the outbreak of the war that Indian officers from the Corps of Indian Engineers were posted to the Survey.

Mrs. SHAW: What is the present proportion of English officers; is it the intention of the Government of India to continue to employ them?

Brigadier HEANEY: I cannot work out the proportion! There are now two British officers in the Survey of India and there will be only one in a few months' time. It is certainly not the intention of the Government of India to retain more British officers than are absolutely essential; I think they will eventually do without any.

The CHAIRMAN: It is now abundantly clear to all of us that the Survey of India has accomplished an enormous amount of work during the last few years, work of a most diverse nature. It is amazing that the Survey has been able to carry on with its purely scientific work, as well as work on the projects about which we have heard, during a period when the Survey might have been forgiven for spending a good deal of time on what I first described as reorientation and re-administration. It only remains for me to ask you to thank Brigadier Heaney for his most interesting lecture.