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Cartographic traditions, innovations and revolutions: The arrival of digital cartography in India

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Abstract

Cartography is known to have existed in antiquity, with the earliest known example being a line etched on a piece of tusk dated to 25,000 BC. Most of the old maps originated in the Mediterranean region. Early Greek geographers also prepared small scale maps of the world. Exploration phase began with the discovery of much of the world in less than a hundred years. The Pre-European tradition of Indian cartography is largely the plans, maps and atlases of the Indian territory or a part of it prepared after the seventeenth century. There is no evidence of an indigenous tradition of map making, but there have been scholars of Indology and Indian history who have sought to demonstrate the existence of surveying and the knowledge of cartography in ancient India. Most of these works and references place heavy reliance on the idea of measurement and geometrical or other specific forms, mentioned in the ancient Indian texts. Unfortunately, today there is no breed of professionals in India called cartographers, no university offers a course leading to a degree or diploma in cartography, and that India does not produce maps of any other continent or country, or a world atlas of some merit. What is needed is a revival of cartography on modern lines by establishing a multi-functional Institute of cartography, with an aim to preserve past cartographic works, train a band of cartographers on scientific lines, and produce maps of all parts of the world including India.

Keywords: *Cartography, map, atlases, GIS, scale, digital age*

Introduction

Cartography as a medium of expression and illustration is known to have existed in antiquity. The historians of cartography go as far as to view a line etched on a piece of tusk, dated to 25,000 BC as a simplified form of cartography. While, this may not quite fit with our idea of cartography, many other representations of the outline of the world, or a part of it, cannot be denied their claim as valid pieces of cartographic representations. "The earliest extant example of a portable map dates to Babylonian empire and is dated circa 3800 BC. The Babylonians were pioneers in the study of the world and its place in the cosmos, crucial in the development of Cartography" (Swift, 2006, p.11). One, however, wonders if clay tablet with an etched impression of a river and a delta, that the Babylonian map represented, could be considered a map.

Most of the old maps, one may call them ancient, generally originated in the Mediterranean region. One of the earliest thinkers was Anaximander of Miletus (611-546 BC), who is credited with drawing the

first map of the known world. Other early maps of the world, howsoever incomplete and crude they may appear, by Hecataeus (550 BC), Eratosthenes (200 BC) and Ptolemy (150 AD), hundreds of years apart, decidedly represent the very early stage of cartographic evolution in the world. Based partly on their knowledge of the physical world and partly on logical imagination, early Greek geographers prepared small scale maps of the world, often confined in a circle. They had a compelling attraction of showing the world (known to them) in a limited circular frame, corresponding with the shape of the world.

The map prepared by Claudius Ptolemy was on a sounder footing, as by mid-second century AD more of the world, especially Asia, was known from the conquests of Alexander and many travellers. But equally pertinent is the fact that by the time Ptolemy appeared on the scene at the close of the second century AD, one of the greatest geographical principles of locational co-ordinates (latitude and longitude) was well established. It would be appropriate to point out that the co-ordinates of a place, expressed by latitudes and longitudes, now taken as a given fact, is a major geographical contribution made by Hipparchus (190– 120 BC), a Greek geographer and astronomer. The co-ordinates were used for the first time by Ptolemy in his well-known semi-spherical map of the world, extending from the shores of the Atlantic in the west to China Sea in the east, with the Ganges delta thrown in the eastern segment.

The appearance of an Arab world in the Mediterranean region, covering a large part of North Africa, part of Spain and other regions around the Mediterranean, coincided with a simultaneous emergence of many Arab scholars interested in the geography of the world. One such scholar who is widely recognised as a cartographer was Muhammad-Al-Idrisi (1100-1169) who produced some of the most accurate maps of the medieval Islamic period, known as *Tabula Rogeriana* (1154 AD), a kind of medieval atlas with 70 sheets. The atlas consisted of a series of rectangular maps, based on the knowledge gathered from travellers. It contained, besides the Mediterranean world, maps of parts of Africa and Indian Ocean. An uncommon feature of the maps was the direction, the north pointing downward, and to orient it according to modern convention, the maps with Arabic scripts had to be turned upside down for a proper orientation.

The exploration phase

Much of the world was discovered in a space of less than hundred years, from the beginning voyage of Columbus in 1492 to the end of the exploratory voyage of Magellan in 1522. Almost at the same time, when Columbus was exploring West Indies and brought forth a wealth of Information about the new world, Vasco da Gama, in an attempt to discover the spice land, sailed east landing at Calicut (now Kozhikode) on the Indian coast in 1498; and Magellan in an effort to find a western route to the East Indies, circumnavigated the world, traversing the Atlantic Ocean, sailing along the east cost of Latin America and crossing over to the Pacific, through the Magellan Strait, reached the Philippines where he was killed by local tribes. James Cook, however, discovered Australia later in the 18th century.

Knowledge and cartography of the globe

What is important to realise is that by the close of the 15th century and the beginning of

the 16th century, the outline of much of the globe, with its oceans and continents was known, enough to induce the cartographers of the world to attempt a map of the earth on the globe. This was also the period of Renaissance when all round growth of knowledge was accelerated especially in science; and this had its impact on cartography as well. The invention of theodolite in the 16th century, much improved by Jonathan Sisson (1725) in what was till lately a modern theodolite, gave the necessary impetus for producing maps based on accurate measurements. It is said that most of the cartographers of the fifteen-century lived either in Venice or Genoa, because it was from these two places that Europeans departed on voyages to the Eastern Mediterranean, to pick up cargoes of valuable items from the east.

Cartography in Europe

Cartography in Europe, to start with, developed in the Low Countries, like Netherlands, though Portuguese and Spaniards were the great explorers. The reason often advanced is the rise of the protestant sect of Christianity that allowed thinking independently without the fear of inquisition by the Catholic Church. There is a long list of cartographers who emerged in the 15th and early 16th century, but these cannot be mentioned for want of space. One of the widely acknowledged however, was Gerardus Mercator (1512-1594) known for the world map he produced in 1569. This was an eighteen-sheet world map, drawn on what is known today eponymously as Mercator projection. In this map projection, the azimuths were represented by straight lines, enabling the navigators to plot their courses by straight lines. This projection became immensely popular with sailors and enjoyed a long lease of life.

Another contemporary of Mercator was Abraham Ortelius. Though the name 'Atlas' for a collection of maps was given by Mercator, the actual atlas, titled *Theatrum Orbis Terrarum* was produced and published by Abraham Ortelius in 1570.

A stable phase in cartography

Sixteenth century onward, a stable phase in the development of cartography occurred. More and more accurate information based on precise survey was added and the quality and accuracy of maps improved speedily. The old maps, like those of Ptolemy were corrected in the light of new knowledge.

Following Mercator, there was a rush for production of maps of sections of the earth, countries, provinces, coastal areas and cities. By the close of the 18th century, most of the continents had a relatively accurate map. The earliest map of Asia entitled "Asia Empires, Kingdom and States" was compiled by Sieur D'Anville (1772).

Early Indian Cartography

There are many references to cartographic works in India. Yet, the British, in general, are credited with surveying and preparing accurate maps of India, or parts of it, on different scales. This is not to say that cartography was not known in India. The Moghul emperors, especially emperor Akbar, had a penchant for surveying, but it is doubtful if they had maps prepared on different scales. According to Irfan Habib, (Proceedings of the Indian History Congress, vol. 35, 1974, pp.150-62), there were maps of the Moghul period that could be included in the history of cartography, while Lahiri (2012) mentioned that in Moghul period, a Persian world atlas showed the inhabited quarters (world) in brilliantly coloured maps.

More relevant, as an important piece of cartography, is the atlas "Maps of Moghul India" drawn by Col. Jean Baptiste Joseph Gentil, agent for the French Government in the court of Shuja-ud-daula of Faizabad, during the 1770s. Titled as *Essai Carte Generale de l'Indoustan ou Empire Mogol* it was published in 1782 and reprinted in 1988 (Manohar). It is difficult to say if Gentil's maps anticipated the maps of James Rennel. One may, however, observe that Gentil's maps were more akin to sketches carrying place names and rivers. These are, nevertheless, valued as they show partial reality of Moghul India in the 1770's.

Arrival of the East India Co., trigonometric Surveys

The central figure in the introduction of modern cartographic techniques and the production of maps in India is James Rennel (1742-1830), a cartographer with interest in oceanography, turned a cartographer, who laid the foundation of accurate mapping in India. Employed by the East India Co. as the Surveyor General of Bengal, he surveyed the Ganges, prepared the Bengal Atlas in 1779, and finally prepared the earliest map of India under the title '*Memoir of a Map of Hindoostan; or, The Mogul Empire*' in 1782.

It may be emphasised that the 'Land Survey' in the USA started in 1785, just when Rennel completed his map of Hindoostan. Though a colonial possession of the British the survey and mapping work started in India much ahead of many other countries. The Knowledge of the land was important to the British colonialists, not only for collection of revenue but also to explore and exploit the country`s rich resources like forests and minerals.

The Survey of India was set up in 1767 to survey and map the country. The actual survey work, however, started in the beginning of the 19th century. Colin Mackenzie, the first Surveyor General of India, remained engaged in surveying the Mysore region to consolidate the East India Co`s hold on the kingdom of Tipu Sultan, after the latter`s fall in 1799. A detailed trigonometric survey was undertaken only in 1802, under the leadership of William Lambton and completed in 1871, during the regime of James Walker, the then Surveyor General of India. During this long period, George Everest of Mt. Everest fame and Andrew Scott Waugh worked as Surveyors General. During this survey, theodolite (a crude one measuring one metre and weighing 50 kg) was used for the first time. The process of triangulation helped fixing The Great Indian Arc of the Meridian, through a web of triangulations that ran roughly along 78° E longitude, covering a distance of about 2400 km. Much of the country was surveyed by the end of the 3rd quarter of 19th century, and was concurrently mapped, putting together the survey results.

The Survey of India produced maps on different scales like million sheets, quarter inch sheet (also called degree sheet), half inch and one-inch sheets, the last being on a scale of one inch to a mile, the largest scale topographic map available till mid-fifties of last century. The introduction of metric system led SOI to transform these maps to 1:1,000,000, 1:250,000 and 1:50,000 (equivalent of old one-inch sheet) and even an enlarged version on a scale of 1:25,000.

Fixing the zero meridian and the international map series

Till the end of the 19th century there was enough confusion about a zero-degree meridian.

It was only in 1884 that an international conference in Washington DC agreed on Greenwich meridian that was adopted as 0° meridian. Secondly, it was during the Fifth Geographical Congress in 1891 in Berne that the proposal to prepare international maps, to cover the entire world, on a scale of 1:1,000,000, using uniform symbols, was accepted. Thus, a set of standard maps- the so-called million sheets- for the whole world were produced. These two aspects, fixing the 0° meridian and the coverage of the world by standard million sheets, greatly facilitated internationalisation of cartographic work.

The Survey of India has done pioneering work in all areas of surveying and mapping, notwithstanding the restrictive policy of the Government of India. They are the custodians of all that is related to maps of the country, revising, updating and incorporating the latest information.

Cartographic revolution: Arrival of the digital age

The arrival of the digital cartography took place in the last quarter of the 20th century. The maps are now stored in digital form that could be reconstructed into a map any time with the flick of a computer cursor. Conversely, the contents of the map could be digitised and stored in digital form to be recalled to make a hard copy. The data that is stored in a matrix of cells in rows and columns, is either vector form that digitises the points, lines and polygons, or in raster form obtained from the satellite imageries in pixel form that depict a segment of the earth. Thus, both kinds of data, stored and subjected to a computer aided Geographical Information System (GIS) provide the map of the area. The Indian Institute of Remote Sensing (IIRS), an affiliate of ISRO (Indian Space Research Organisation) has been able to train a number of earth scientists in the science of Remote Sensing, GIS, and the construction of maps. The result is that most universities in India have started a certificate or diploma or even a degree course in GIS and Remote Sensing.

The application of GIS and Remote Sensing has generated a belief and even an understanding that the conventional cartography, embodying scientific principles and aesthetic elegance, is no longer needed to make maps and atlases. The satellite images, representing the results of remote sensing have enough information to enable a trained cartographer to produce maps and atlases using conventional signs and symbols. In other words, it is possible to directly transform the imagery into a conventional topographic map. Of course, many of the non-visible attributes have to be incorporated when a thematic map is prepared. The thematic maps are quite amenable to digital cartography.

The big debate

The satellite imageries constructed from raster data could be transformed into a map like a topographic sheet, with all the visible features. The questions: has the country, with many university departments specializing in GIS and Remote Sensing, been able to produce maps and atlases, based on these imageries or using the stored vector and raster data? Have we produced regional atlases by manipulating the GIS data? Or, the 'GIS and Remote Sensing' will remain confined to class rooms, as a theoretical exercise. One does not deny that there are multiple uses and advantages of GIS and Remote Sensing, and its importance as a field of applied science cannot be over-emphasized. Some of the commercial concerns like Google have

utilized the remote sensing technique to a very advanced level, to the extent that there is hardly an individual who remains untouched and does not use Google in one form or the other. Yet, we are talking of cartography.

Even today, some of the most informative and aesthetically most appealing atlases continue to be produced. Another aspect is the mapping of non-geographical information, like historical facts, social organization, or the cultural practices, where an expanded skill and a degree of imagination is required to give these different aspects a visual form. It would go much beyond remote sensing. The situation will be salvaged only by a trained cartographer applying even graphic art where necessary.

Imageries are not maps

Though satellite images are not maps, they are very useful in observing the ground details. These can, no doubt, be manipulated by applying certain software to classify, calculate and roughly map the surface, without any attribute and names inscribed on them. The real question is – are the historical atlases (like the "Historical Atlas of South Asia" by Joseph Schwartzberg) or cultural or demographic atlases amenable to GIS and Remote Sensing exercises? The question one may ask – with a band of trained personnel and increased capacity built in the universities, are we able to produce maps and atlases? The benefits of imageries are obvious in engineering works, forest management, agricultural land use and many other fields, but, could these replace the conventional atlases and maps?

Why India does not produce maps of other parts of the world?

The world over, maps are produced on different scales on a commercial basis and marketed globally. One can buy a map of India, or any other part of the world, on a scale of 1:1,300,000 with as much information as our million sheets contain, or even more, from overseas sources. A map of India and Pakistan could be brought with 250 m contour interval on a scale of 1:1.3 million. Similarly, all kinds of atlases are produced all over the world. Neither the Survey of India nor any other commercial enterprise in India produces maps of other countries or other parts of the world, and remains tethered to producing topographic, thematic maps and atlases of India. Survey of India, the National Atlas and Thematic Mapping Organization (NATMO), both government organisations, have stuck to traditional mapping, or prepare maps in a "mission mode" as required by the government of India.

As I see, GIS and Remote Sensing has become a highly technical subject. The earth scientists and most government departments, like agriculture, mining, forests, fisheries and many others, are users of its products, mainly satellite imageries. But, where is cartography?

Teaching and research in cartography

There are still institutes in Switzerland and Germany, among other countries, which offer masters programme in cartography. It is something different from GIS and Remote Sensing. The latter is a part of the entire course structure. Let there be no impression that the art and the science of cartography is redundant.

India badly needs an institute of cartography, as an autonomous institute or an affiliate of the Survey of India. Such an institute will not only teach the latest development in cartography, but will explore the frontiers of the science of map-making.

If established, it would be a depository of all possible maps of all parts of the world and atlases and other cartographic literature, and a permanent source of all information relating to maps of any part of the world. It may take time, but a cartographic library could be built over the years.

The Indian cartographic tradition

In the present context, it appears appropriate to look at the tradition of Indian cartography as a segment of cartographic evolution. There is some advantage in looking at the Indian tradition in two parts: 1. Early and Pre-European tradition, if any, of cartography in India, and 2. European inspired, promoted and executed works of Indian cartography. In the first case, one looks at the cartographic works executed before 16 the century: and in the second category, it is largely the plans, maps and atlases of the Indian territory or a part of it prepared after the seventeenth century. It is based largely on the work of Survey of India, starting with the works of James Rennel, the Surveyor General of Bengal, and subsequently of the Survey of India (SOI) and the latter`s unparalleled achievements in the 19th century. More light is thrown on SOI, in the sequel.

Pre-European tradition of Indian cartography

Did anything like an Indian cartographic tradition exist? In a survey of writings of Indian historical geography, as a part of the Survey of research in Geography by Indian Council of Social Science Research (ICSSR) Raza and Ahmad (1972) observe that "there exists no evidence of an indigenous tradition of map making". While this may be a generalized view of geographers, there have been scholars of Indology and Indian history who sought to demonstrate the existence of surveying and the knowledge of cartography in ancient India. Tripathi (1963) has quoted different ancient texts, especially the *Sulavasutra*, to demonstrate that the art of surveying and cartography were known to Indians. He elaborated his view further in his book "Development of Geographic Knowledge in ancient India- (Varanasi-1969) in which there is a long chapter on" Survey, Cartography and Cartographic Symbolism". References to Ancient Indian Cartography also appear in Sircar's "Studies in the Geography of Ancient and Medieval India (1981)". Most of these works and references place heavy reliance on the idea of measurement and geometrical or other specific forms, mentioned in the ancient Indian texts. In the opinion of the present author, nothing that is known by way of references of measurements, survey work, or geometrical and astronomical figures and calculations, either from the *Vedic literature or* from other ancient texts, puts us on an unassailable ground to establish definitively the existence of a cartographic tradition in ancient India.

The views of several Indologists who thought that there existed a tradition of survey and cartography in Ancient India is evaluated by Schwartzberg (1992) in chapter-2, "Introduction to South Asian Cartography", that he contributed to the "History of Cartography", a much larger work containing several volumes. Schwartzberg, like many others, believes that although there are grounds to suppose that "Indians produced maps for roughly two millennia, before the advent of the Portuguese- and possibly over a considerable longer period, virtually nothing in the way of ancient cartography survives.

"*In fact, apart from incised pot shreds of the second or first century BC that bear rough plans of monastery and a few ancient sculptures depicting sacred rivers, there is no extant cartographic or cosmographic of a distinctly Indian stamp that can be unequivocally dated to any date earlier than 1199-1200, the date of a Jain bas-relief representation in stone of the mythical continent Nandisvardvipa which to European eyes would not appear to be a map*". Yet, more than sixty percent of the length of the chapter Schwartzberg talks of Indian antiquaries, starting from Vedic times including the *Sulava Sutra, the satapatha Brahman, Mahabharata and Ramayan*, and, in the process, invents a new term called "verbal cartography". Schwartzberg quotes Basham to show that there were measurements of land during the Mauryan period and Stella Kramrisch to suggest that the old Hindu temples involved advanced planning and measurement according to a plan.

His elaboration of Indian cartography contains sub-titles like `The Nature of the Indian Corpus Textual Sources and Archaeological Record" wherein he discusses the Harappan culture, the Vedic sacrificial altars, and ancient knowledge of geography and cosmography, Indian astronomy, model architectural plans, from ancient and medieval India. By way of illustrations, he reproduces sixteen figures which include cave paintings, bas-relief, sketches of sacrificial altars, including a plan of Jaipur.

While going through his writing of the traditional Indian cartography, one cannot escape the feeling that he has struggled to collect and include everything, he laid his hands on, relating to Vedic rituals, ancient Indian iconography and astronomy and even cave painting and pieces of bas-relief. For example, the reproduction of Ganga-Yamuna in bas-relief at Udaigiri (Ujjain-MP) as a piece of cartographic work would appear incongruous, if not outright absurd. Similar is the case of rock paintings of Bhim Betka - a place forty km from Bhopal-or Mahararia from Mirzapur in UP, taken from secondary sources and reproduced in the text, could by no stretch of imagination represent a map.

It appears, in his efforts towards discovery of cartographic pieces in India, and document all that he discovers by way of non-textual material like pre-historic figures, paintings, bas-relief, remnant of sketches, or even description that suggests measurements of land, he includes in his enumeration of the corpus of Indian cartographic work.

Cartography in medieval India

One of the oft-quoted authors and a savant of Medieval India, Ahmad-al- Biruni, though very distinguished man of letters, and familiar with India, wrote Kitab-al-Hind besides a history of India - *Tarikh al-Hind*. Elsewhere he compiled a list of places and the distances between them, but produced hardly anything that could qualify as a cartographic work.

More to the point are the frequent references to Mughal cartography, especially during emperor Akbar`s time as recounted by a Jesuit, Father Monserate who recorded the fact of measurement of roads, along the marches and quotes the journey of Akbar from Delhi to Kabul. This gave rise to what are referred as strip maps, referred to in the memoir of James Rennel. Some maps- and probably the only ones, of medieval India are found in the edited volume - "*Maps of Mughal India*", an atlas commissioned by Col Jean Baptist Joseph Gentil (1770). These maps were edited and reproduced by

Susan Gole (1988) who observed that "For the first time, the map of India was drawn from an indigenous source and showed the political divisions of local administrative units according to local sources and not from the grabbed account of foreign visitors". With 21 maps, the collection of maps by Gentil is unique as it is a pre-British, but contained maps only of Mughal India. It may be noted that Col. Jean-Baptiste-Joseph Gentil was an agent of the French Government to the court of Shuja-ud-daula at Faizabad for 25 years, and was familiar with the Gangetic basin. His maps, therefore, included the *Doab*, the river Ganga, the cities along it and even some parts of Bay of Bengal coast, from Calcutta to Ganjam.

The Mughal cartography, as an art, has been quoted by Irfan Habib who emphatically mentioned the existence of a 17th century world atlas, contained in a larger encyclopaedic work by Sadiq Isfahani of Jaunpur. There is no doubt that the Mughals had an idea of survey and measurement of land, and may have produced cadastral maps, but whether they produced large scale maps of their empire or part of it, is questionable. More commonly, they knew the routes and distances from which they may have produced route maps.

Cartography under European tradition

This refers to the maps of India or its regions prepared on scale by Europeans or others under their direction. In this category no one gets precedence over James Rennel, a founder member of the Royal Geographical Society, but in our context, the Surveyor General of the East India Co. Starting with the Survey of Ganges for navigation (1764), he produced several maps of Bengal, put them together in an atlas "A Bengal Atlas-1779", and finally produced his most famous cartographic work- *Memoir of a Map of Hindoostan*; Or, *The Mogul Empire*" (1782). This was the beginning of a long process of surveying and map making in India. Though not very accurate, Rennel`s map of Hindoostan was the first of its kind, drawn on scale on a network of latitudes and longitudes, and carrying a gazetteer at the end that could help the future map makers. What is overlooked is the inscription on the title page and the cartouche, an ornamental part in most of the maps of earlier period. The cartouche in Rennel`s map carries a halftone picture of Britannica with a number of Brahmans with their sacred books in a posture of subjugation with the following inscription at the bottom- "*Britannia receiving into her protection, the sacred books of the Hindoos, presented by pundits or learned Brahmins: an allusion to the humane interposition of the British legislature in favour of the Natives of Bengal" in the year 1781. In the cartouche Britannia is supported by a pedestal on which are engraven the victories, by means of which the British nation obtained and has hitherto upheld its influence in India*"- a very demeaning statement. One may justifiably ask: was it an honest exercise in map making or just "cartography in the service of the empire, as suggested by Dikshit (1998). This shows what the entire apparatus of East India Co. thought of Indians.

Survey of India

Survey and map making in India under the European tradition is synonym with the Survey of India (SOI). Established in 1767, much of the survey and cartographic work in India on modern lines was started by SOI and, SOI is still the sole government organization engaged in survey and cartographic work.

The most difficult task accomplished by the SOI, way back in the beginning of the 19th century, was the survey of the country by triangulation and fixing of the prime meridian as a reference meridian as discussed earlier. The survey work started in 1802 and ended in 1871. It may be mentioned that the survey and mapping of India was a pioneer work, and one of the earliest exercises in triangulation and mapping in the world.

In passing, one may mention the contribution of India in the triangulation survey. The British Engineers and surveyors trained the Indians in the art of surveying and even trigonometric calculation, especially the surveyors from Bengal. But, the most famous story is that of Nain Singh and his brother who found the way to, and details of, several geographical features of Tibet including the height of Tibet. Trained at Dehradun for a couple of years to travel incognito, Nain Singh`s achievements are the stuff of a folklore, associated with the SOI.

The maps prepared by the SOI, such as the topographic maps, small scale maps, atlases, town maps or maps of certain areas, are a legion. In fact, maps and map-making in India is virtually synonymous with the SOI. India is privileged to have inherited such an organization with an enormous archive of maps, charts, documents and historical records.

Besides the Survey of India, there are a couple of other Governmental organisations that produce maps and atlases. These include National Atlas and Thematic Mapping Organisation (NATMO). Known earlier as the National Atlas Organisation (NAO), it was established by the Government of India in the fifties of the last century, under the directorship of Professor S. P. Chatterjee. Starting with a modest beginning the organisation has grown admirably, producing today largely thematic maps as required by the government of India. Staring with a general atlas of India on a scale of 1:5,000,000, and subsequently maps of different parts of India on a scale of 1:1,000,000, NATMO now produces maps of different genres- regional, thematic, or even problem-oriented maps. Besides NATMO, the Census of India has started producing excellent thematic maps of languages, tribes or other aspects of Indian population. Census of India has a very old tradition of map making. Some of the early maps of Bengal carry excellent pieces of cartographic work. Directorates of Statistics of certain states produce Statistical Atlases that contain the latest statistical information. Most Government ministries and departments have their own cartographic sections to produce required maps. Lately, some private organisations like “Map My India” have started producing maps under licence from Survey of India.

Contribution of Indian geographers

The contribution of Indian Geography to cartography in general, and the cartography of the country, in particular, is manifold. Firstly, they have kept the science of map making alive. Most universities have courses on surveying, map projection and statistical mapping. Some have contributed by physically producing a set of maps. To start with *Bengal in Maps* by Professor S.P. Chatterjee, was a unique contribution for its time. A similar effort was made by G. S. Ghosal who produced an Atlas *Punjab in Maps*. Map and atlas making exercises got a head start after 1958, after the publication of the Regional Planning Atlas of Mysore, by A.T.A. Learmonth and L. S. Bhatt. Though a sponsored project of the

Planning Commission, the latter paved the way for several subsequent Planning atlases like Manzoor Alam`s *Planning Atlas of Andhra Pradesh* followed by a *Planning Atlas of Uttar Pradesh* by L. R. Singh. During the last quarter of the last century a few thematic Atlases were produced by geographers. The *Tribal Atlas of India* by Moonis Raza and Aijazuddin Ahmad, or the *Atlas of Women and Children* by Saraswati Raju and the *Atlas of Chandigarh* by Gopal Krishan readily come to mind. The *Historical Atlas of India and Pakistan* by Joseph Schwartzberg is a world apart. It is a cartographic *piece de resistance*. Some of the publishers, notably Oxford University Press, have produced a few India centric atlases. Besides the *Oxford School Atlas* that has gone into multiple editions, they also produced an *Economic Atlas of India* and lately *Oxford Reference Atlas*. Going beyond its traditional brief, the SOI, under the directorship of Dr. Prithveesh Nag, has produced a series of *District Planning Maps* of a large number of districts of India, on a scale of 1:250,000. These large-scale planning maps make a good starting point to have one familiarized with any region.

In this context, it is important to mention a couple of works on history of cartography. The three authors that have to be acknowledged, are Professor Joseph Schwartzberg, celebrated author of *Historical Atlas of South Asia*, Susan Gole, and Manosi Lahiri, the last one a hard-core geographer and cartographer. All the three have contributed to the history of Indian cartography in their own ways. While Schwartzberg wrote a number of articles for the history of cartography project, Gole and Lahiri produced a collection of Indian maps from the archives and made them available to those interested in Indian maps. The most well-known work of Gole is her *Indian Maps and Plans- from Earliest Maps to the Advent of European Survey* (1983), followed by a companion volume *India within the Ganges* consisting of a series of early printed maps of India in facsimile and the edited volume of the *Maps of Mughal India* drawn by Col. Jean Baptiste-Joseph Gentil, referred to earlier. Manosi Lahiri's (2012) *Mapping India* is a collection of 160 annotated coloured maps. Running into 320 pages, the book, more like an atlas, could be considered the latest addition to history of Indian cartography.

Where is Indian Cartography?

There is no breed of professionals in India called cartographers. In some countries, there is a class of qualified trained cartographers called "Cartographer Engineer", and the university departments and other Government organisations hire these cartographers. No university in India, to my knowledge, offers a course leading to a degree or diploma in cartography. The second most important point is that India does not produce maps of any other continent or country, or a world atlas of some merit, besides its own the country depends on international publishers, like Oxford, Phillips or any other, for an atlas. Nor does the country produce medium scale maps (1:200,000, or 1: 1,500,000) of different countries or parts of the world. The most and readily available map of any part of the world are the million sheets of international series on 1:1,000,000 scale. Whatever may be the past achievements or non-achievements of Indian cartography, the state of map making in India, today, is a sad commentary on contemporary Indian cartography. What is needed is a revival of cartography on modern lines by establishing a multi-functional Institute of cartography, with an aim to preserve past

cartographic works from all possible sources, train a band of cartographers on scientific lines and produce maps of all parts of the world including India.

Contemporary cartography in India

Besides the Survey of India, the premier producer and keeper of maps in the country, the most visible cartographic organisation in India is the Indian National Cartographic Association. It holds its annual conferences, often hosted by some geography department or other of an Indian university. It is difficult to find, if one exists all, a department of cartography in any university in India. To a question, if there are any acclaimed cartographers in India, may bring a negative answer. What is known since long is the interest and profession of geographers as makers and users of maps. Map making has been an integral part of geographical teaching in Indian colleges and universities. Unfortunately, with the advent of Remote Sensing and Geographical Information System, the actual map making has receded in the background. Copying, often from unauthorised sources, digitising and use of available software has made map making exercises redundant.

Google`s over-arching reach

The appearance of Google maps has charmed and stunned every user of maps. When you need a map, you turn to Google, not to some atlas with a gazetteer or a topographical sheet. To be fair to Google, a private entrepreneurial enterprise, it has done a tremendous work not only as a search engine, but also by producing Google Earth with multiple layers of information, and a built-in programme for scale adjustments, carrying some basic information that pops up the moment you touch a location on the map. These maps have packed in so much of data that are usually unavailable from a simple map. Distances, heights, relief profiles are all integrated in a Google map. The fall out of this is that with a laptop or a smart phone, one can scan enough information about a place or a region. A person with a smart phone will tell you the coordinates, the height, and distances and many other details in a few seconds, whereas in an atlas one has to look at the gazetteer, given at the end, to know the coordinates, estimate the height with the help of the nearest contour, or measure distances on the map by using the scale. Google has integrated software in the Google maps that does these simple jobs at electrifying speed.

Yet, these devices or facilities represent only a part of the entire gamut of cartographic work. It must be remembered that Google has utilized survey maps, topographical sheets, atlases, and other details for identification, processed them, subjecting them to software that produces multilayered maps which come handy. The satellite images are their own, or obtained from national agencies, but other details, specially the identification of ground features must have been obtained from some maps. To take an example – How would Google know the name of a village, say Chak -179, in Punjab from a satellite? In such cases, these agencies have to depend on secondary sources. It is hard to imagine that Google has employed manpower to cover the entire face of the earth, to survey, and complete the identification exercise. How would the satellites know the names of the ground features? These must have been borrowed from secondary sources, regional, local or city maps, or done through human resource identifying and inscribing names.

Secondly, Google`s achievements are nothing to be proud of for our country. That is the success story of a commercial enterprise with its based in the USA. Google borrows heavily on the centuries of accumulated work of engineers, surveyors and cartographers to collect information, process it, and present to us, as a ready *Menu*, to be used freely by anyone. In the country and its geographers have not produced a standard geographical atlas nor is there any publishing house of Indian origin that has undertaken this specialized task of map and atlas making. Oxford, for long specialised in atlas making, are still the best producers of atlases. Their school atlas for a modest price of Rs 150/- is the best in its class.

The fact is that though the Government of India is very strict about adhering to a pre-established authenticated international boundary, cartography, as an art and science, has suffered a complete neglect. The Government of India must think of an Institute of Cartography to train and prepare cartographers trained in all aspects of cartography.

In the light of the above discussion one may pose a few questions:

1. Is GIS and Remote Sensing a substitute for cartography?
2. Can we do away with the Science and Art (the aesthetics involved) of cartography?
3. Is it not the function of cartography or cartographers to produce good maps and atlases, thematic and topographic, taking necessary inputs from GIS and Remote Sensing?
4. Why have Indian cartographers, including those specialized in GIS and Remote Sensing, have not produced district, state and country's atlas, or the mountainous and highly inaccessible areas, by applying the knowledge of GIS and Remote Sensing?
5. My view is cartography is the Art and Science of map making and GIS and Remote Sensing are the scientific tools for spatial analysis.
6. Let the scholars, especially geographers, who have been traditional makers and users of maps, produce some maps and atlases of our country or any part of the world, using their expertise. Let cartography not disappear from the scene altogether.
7. The freely available geo-platform of 'Google' with layers of details at different scale for consultation is neither our creation, nor can these be printed as an atlas, which besides being akin to plagiarism and may be interpreted as infringement of copy right act. Also, as mentioned above. Google is not an Indian creation
8. The 'Bhuvan' Geo-platform, made thankfully available by ISRO, is some consolation. But, it hardly compares with the quality of Google. Besides having a limited coverage unlike Google which has a global reach. The main question, however, remains: Does it eliminate the need for map making? If the maps produced in the Indian research journal are any guide, I dare observe that a large number of Indian geographers, if not all, shabbily adopt the spatial details from Google or somewhere else. These maps lack clarity.
9. Those interested in map making may seriously think of an Institute of Cartography as mentioned above.

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