CHAPTER 8

Indus, Ganges, and Beyond

Dharma and Karma

Urban civilization flourished continuously on the Indian subcontinent for at least 1,500 years before the first university appeared in Europe. As we might expect, Indian experts pursued professional and highly exact work in mathematics, astronomy, medicine, and several other sciences.

In recent decades the scholarly study of science and civilization in China has influenced historians concerned with the history of science and technology in India. But, alas, no comprehensive synthesis has yet appeared to match the studies of China. Historians have examined the texts of Indian astronomers, mathematicians, and doctors, sometimes with a now-familiar attitude that attributes all sorts of "firsts" to early Indian scientists. Although circumstances are changing, much more research remains to be done to fathom the Indian case. Here we can only suggest that the earmarks of a typical bureaucratic civilization again present themselves in India: irrigation agriculture, political centralization, social stratification, urban civilization, monumental architecture, and higher learning skewed toward utility.

Compared to China or the Islamic world, traditions of research in the natural sciences were less vigorous in India. In part at least, the otherworldly, transcendental character of Indian religions militated against the direct study of nature. In various ways, the major religions of Hinduism, Buddhism, and Jainism envision the everyday world as a grand illusion with a transcendental theological reality underlying an ephemeral world of appearances. In these philosophies, unlike Platonic or later Christian traditions, no correspondence unites the world we see with the abstract realm of a greater reality. Truth, then, remains wholly metaphysical and otherworldly, and the goal of knowledge becomes not the understanding of the ordinary world around us, but rather to transcend this world, to escape its debilitating karma, and to ascend to a higher plane. Spiritually very rich, such views did not focus traditional Indian thinkers on the natural world itself or on any underlying regularities in nature or nature's laws.

Civilization arose along the Indus River Valley in the third millennium BCE (see chapter 3), but declined after 1800 BCE for reasons that remain unclear, but that probably resulted from shifting ecological patterns. The society that followed was not an urban civilization but rather consisted of decentralized agricultural communities, tribally organized and each headed by a king and chief priest. In time, settlements spread from the Indus to the Ganges basin in eastern India. Four orders or estates constituted early Indian society: priests, warrior-nobles, peasants or tradesmen, and servants, a social division out of which later emerged the full complexities of the Indian caste system. This fourfold division tended to break down local or regional identities in favor of "class" identities. The priestly class (the Brahmin or Brahman) guarded lore and ritual expertise, without which the universe would supposedly collapse. The Brahmin monopolized education, enacted ceremonies, advised kings, participated in statecraft, and drank of the hallucinogenic beverage *soma*.

The historical picture of India down to the sixth century BCE remains fuzzy, depending wholly on literary evidence from religious texts known as the Vedas of the period 1500–1000 BCE and auxiliary Brahmanic commentaries compiled in the succeeding 500 years. Originally oral works, they became codified only with the advent of writing in India in the sixth century BCE. Certain obscurities aside, these early texts reveal the existence of scientific knowledge directed at the maintenance of the social and cosmic orders.

Given the centrality of the sacred Sanskrit texts and the "magical" power of their oral recitation, linguistics and grammatical studies became the first "sciences" to develop in India. The Sanskrit language and the Vedas formed the basis of all study, and many grammatical and linguistic guides were produced to lead novices and experts through their intricacies. The fifth-century BCE Sanskrit grammar of Panini, for example, set out 3,873 aphoristic rules concerning grammar, phonetics, meter, and etymology. The importance of oral recitation of the Vedic scriptures likewise led to traditional studies of acoustics and analyses of musical tones.

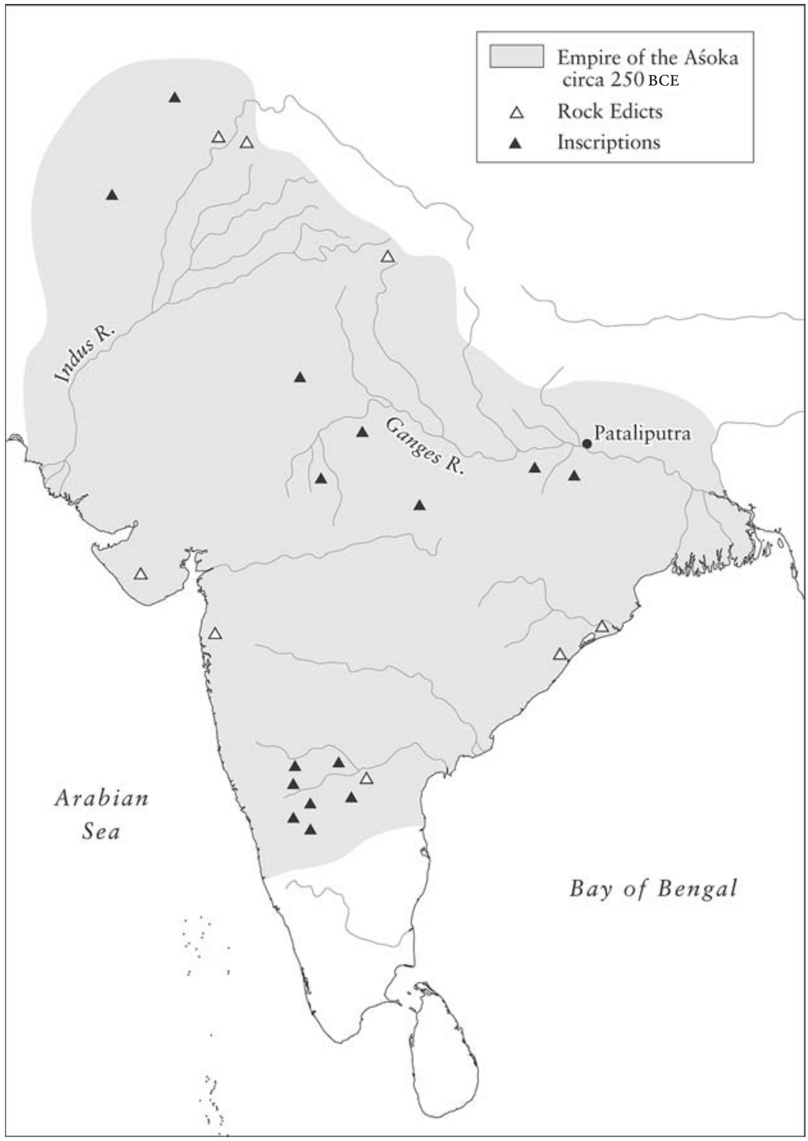
A smaller, subsidiary group of Vedic and Brahmanic texts concerned astronomy and mathematics. They make plain that a high-status professional class of priests, astrologers, stargazers, and calculators functioned within Vedic society. Experts created and maintained a calendar in order to regulate Brahmanic ceremonies and sacrifices that had to take place on specific days and in specific months and years. They developed multiple solutions for dividing the solar year into months and for intercalating an extra month to keep the religious calendar in synchrony with the solar year. The moon possessed astrological significance, and, like the Chinese, early Indian astrologers divided its monthly course across the heavens into twenty-seven (sometimes twenty-eight) constellations or "lunar mansions" (*naksatras*). The Vedic-Brahmanic calendar thus united lunar and solar cycles. The construction and orientation of altars was a related affair of high importance, for which mathematical competence proved essential. At early stages of Indian history, Indian mathematicians also explored very large numbers in keeping with Hindu and Buddhist notions of great cosmic cycles, giving names for numbers up to 10^{140}.

The Indian subcontinent was more open to outside influences than was China, and so, too, were Indian scientific and technical traditions. The invasion of India by the Persians in the sixth century BCE and their subsequent 200-year occupation of the Indus Valley opened the door to Persian and Babylonian influences on Indian astronomy. Similarly, the invasion by Alexander the Great in 327–326 BCE allowed Greek science to begin to diffuse into India. Conversely, Indian scientific and technical accomplishments influenced developments in the Islamic world, China, and Europe.

At least one relatively powerful kingdom (the Magadha) arose in India by the fourth century BCE. Until then no single polity united India but, triggered by the invasion of Alexander the Great, the Indian adventurer Chandragupta Maurya forged the first unified empire on the subcontinent, reigning as the first Mauryan king from 321 to 297 BCE. His grandson Aśoka expanded the realm during his reign from 272 to 232 BCE. One study claims that the contemporary Mauryan empire, centered on the Ganges, was then the largest empire in the world.

With the advent of the Mauryan empire greater clarity emerges in the historical record. The Mauryan empire was first and foremost a great hydraulic civilization. A Greek traveler, Megasthenes, spent time at Chandragupta's court around 300 BCE and relates that more than half of the arable land was irrigated and that, as a result, Indian agriculture produced two harvests a year. A special department of state supervised the construction and maintenance of a well-developed irrigation system with extensive canals and sluices, and the same bureau planned and directed the settlement of uncultivated land. Land and water were regarded as the property of the king, and the Mauryans levied charges on water taken for irrigation. With no intervening agencies between peasants and state tax collectors, peasants held lands in a kind of tenancy, and henceforth in Indian history the state received its main revenues in the form of ground rents. Irrigation thus proved essential to both food production and state revenue, and it also fortified political centralization. Archaeological evidence of ancient irrigation systems remains elusive, largely because rivers have so changed their courses since the onset of historical times in India. Documentary evi-

Map 8.1. India. One of the major civilizations, India spread from its initial origin in the Indus River Valley eastward to the Ganges River and to the south of the Indian subcontinent. In the third century BCE India became united under Chandragupta Maurya. The map shows the extent of the Mauryan empire under his grandson Aśoka.



dence, however, reflects the importance of the hydraulic infrastructure—it tells that under the Mauryans breaching a dam or tank became a capital offense, punishable by drowning.

The Mauryan empire did not lack the other hallmarks associated with hydraulic civilizations. An elaborate bureaucratic structure administered the empire. In addition to the department concerned with rivers, "digging," and irrigation, a number of regional and urban superintendents—all salaried officials of the king—dealt with commerce, weights and measures, excise, the mint, registration of births and deaths, supervision of foreigners, and the overseeing of such state industries as weaving, salt provision, mining, and iron-making. State control of the economy was a characteristic feature of Mauryan society and, indeed, artisans owed some royal service. Mauryan political success originated with and depended upon its military strength, and a complex war office with six subsidiary departments administered and provisioned a paid standing army of nearly 700,000 men and thousands of elephants. The existence of an elaborate bureaucracy of royal spies bolstered the autocratic nature of Mauryan government.

The growth and increasing wealth of cities under the Mauryans are additional earmarks of a developing civilization. Sixty-four gates, 570 towers, and a 25-mile defensive wall guarded the capital city at Pataliputra (present-day Patna) at the confluence of the Ganges and Son Rivers. Within the city, amid two- and three-story houses, the Mauryans erected a monumental wooden palace, replete with gilded pillars and an ornamental park with lakes and an arboretum. The Mauryans undertook other public works, including a communication system linking the empire with tree-lined roads, public wells, rest houses, and a mail service.

Although the details remain sketchy, it seems evident that expert knowledge continued to be deployed under the Mauryans. The social position of the Brahmin with their priestly expertise was not seriously undermined during the period, despite Aśoka's conversion to Buddhism. Mauryan cities became centers of arts, crafts, literature, and education; the administration of the empire clearly required literacy and numeracy. We know that the superintendent of agriculture, for example, compiled meteorological statistics and used a rain gauge. One of Aśoka's rock-edicts—carved inscriptions erected across his empire—also refers to his having established infirmaries for people and animals. And Babylonian and Hellenistic influences came to be felt in India at this point, especially in astrology. For example, the Greco-Babylonian zodiac of twelve houses or signs of 30 degrees each entered Indian astronomy and helped establish its astrological nature. Doubtless, further research will reveal more of Mauryan astronomers and astrologers and their attachment to powerful patrons.

The Mauryan empire declined after Aśoka's death, and India splintered into a host of smaller kingdoms and principalities. More than 500 years passed before India once again regained a unified status, this time under the reign of the Guptas in the fourth century CE. The founder of this dynasty, Chandragupta (not to be confused with Chandragupta Maurya), ruled from 320 to 330, and his better-known grandson Chandragupta II (Chandragupta Vikramditya) held power from 375 to 415. The period of the Guptas continued until roughly 650 with some discontinuities and represents the golden age of classical Indian civilization. The Gupta empire resembled that of the Mauryans in its strong central power, public works, regulation of trade, and revenues from ground rent. The Gupta period is noted for the flourishing of Hindu art and literature, for traditions of liberal royal patronage, and for systematic scholarship in astronomy, mathematics, medicine, and linguistics. It formed the high-water mark of classical Indian science.

No less than earlier, Indian astronomy under the Guptas remained a practical activity. Trained professionals created calendars, set times for religious exercises, cast horoscopes, and made astrological predictions, with "lucky days" for agriculture as well as personal fortune. Indian astronomy was not especially observational or theoretical, and it did not delve into the physics of celestial movements. The emphasis remained entirely on astrological prediction and computational expertise. Furthermore, because of its putative roots in the ancient Vedas, Indian astronomy remained a conservative, backward-looking enterprise that placed no premium on theoretical innovation. Isolated from the rest of Indian intellectual life, astronomers acted more like specialized priests, with technical expertise passing down in families from one generation to another. Unlike astronomy in China, the Islamic world, or Europe, where consensus generally united scientific traditions, some six regional schools of Indian astronomy-astrology competed for intellectual allegiance and material patronage.

Despite its limitations and divisions, Indian astronomy became highly technical and mathematical in the period of the Guptas. From the fourth through the seventh centuries various Indian astronomers produced a series of high-level textbooks (*siddhānta* or "solutions") covering the basics of astronomy: the solar year, equinoxes, solstices, lunar periods, the Metonic cycle, eclipses, planetary movements (using Greek planetary theory), seasonal star charts, and the precession of the equinoxes. Aryabhata I (b. 476 CE) lived in Pataliputra, composed a *siddhānta,* trained students, and held the unorthodox view that the earth rotates daily on its axis (despite his knowledge of Ptolemy's *Almagest*). In his *siddhānta* in the following century the astronomer Brahmagupta (b. 598 CE) repudiated Aryabhata's notion of a moving earth on the grounds that it violated common sense and that, were it true, birds would not be able to fly freely in every direction. Brahmagupta's estimate of the circumference of the earth was one of the most accurate of any ancient astronomer.

Indian astronomy depended on precise arithmetical calculations, and Aryabhata and Brahmagupta obtained renown as mathematicians no less than as astronomers. Algebraic and numerical in character, Indian mathematics by and large reflected practical concerns and eschewed general solutions in favor of "recipes." Aryabhata employed a place-value system and decimal notion using the nine "Arabic" numerals and zero in his work. (The appearance of zero within the context of Indian mathematics may possibly be due to specifically Indian religio-philosophical notions of "nothingness.") He calculated the value of π to four decimal places, a value later Indian mathematicians extended to nine decimal places. In his *siddhānta* Brahmagupta extended earlier work on measurement, algebra, trigonometry, negative numbers, and irrational numbers such as π. Indian mathematical work became known to the West primarily through reports by the eleventh-century Islamic scientist al-Bīrūnī in his *History of India.*

As in civilizations elsewhere, the world of doctors and medicine became solidly institutionalized and developed. Wealthy and aristocratic families patronized physicians, and court physicians possessed especially high status, in part because of their expertise regarding poisons and snakebites. Top-level physicians seemingly differentiated themselves from empirics through training and licensing. A traditional medical text, the *Charaka Samhitā,* for example, speaks of a process of apprenticing with a master physician-teacher and getting royal permission before practicing medicine. The religious center at Nalanda flourished as a medical school from the fifth through the twelfth centuries CE. Thousands of students (reports vary from 4,000 to 10,000) and hundreds of teachers studied and taught at this vast complex, more than a mile square with 300 lecture rooms and a large library. Tuition was free, supported by the king and by rich families. Other teaching centers existed at Taxila and Benares. As mentioned, the Mauryan king Aśoka established medical infirmaries, and charitable dispensaries also existed in the Gupta period. Not surprisingly, veterinary medicine for war horses and elephants reached a high level of competence in India from the fourth century BCE.

Medical theory and practice became quite developed early in Indian history. The Vedic oral tradition reported anatomical information, particularly of the sacrificial horse, based on dissection, as well as botanical information and descriptions of diseases. The tradition known as the *Ayurveda*—or the "science of life"—began to be codified in the sixth century BCE, and it came to include sophisticated medical and physiological theories and treatments that involved maintaining equilibrium balances between and among various bodily humors. Ayurvedic medicine is famous for its rational approaches to diseases and their cures and, indeed, it possessed a self-conscious epistemological dimension in assessing the processes of medical reasoning and judgment. The standard medical compendium by the physician Charaka (the *Charaka Samhitā*) appeared around the first century CE. Reflecting the Hindu penchant for naming and listing, the *Charaka Samhitā* identifies 300 different bones, 500 muscles, 210 joints, and 70 "canals" or vessels; its associated nosology of diseases was no less elaborate. A related "collection" by the physician Susruta (the *Susruta Samhitā*) became a bible for Indian surgery. At their heights Indian medicine and surgery were probably the most developed and advanced of any contemporary civilization.

Alchemy, another science deemed to be useful, also flourished in India, perhaps having arrived from China. Closely associated with medicine and the sect of Tantric Buddhism, Indian alchemical treatises focused on various forms of mercury, on preserving health, and on the creation of an undecayable body. Practitioners came to master a sophisticated corpus of chemical knowledge that found applications in medicine through elixirs, aphrodisiacs, and poisons.

Quite apart from these scientific developments, traditional India became a highly evolved technological civilization. Indeed, although not heavily mechanized, India has been labeled "an industrial society" for the period before European colonialism and the Industrial Revolution established themselves on the Indian subcontinent. The major industry in India was textiles, and India was then the world's leading textile producer. The caste of weavers, for example, stood second in numbers only to the agricultural caste, and textile production gave rise to subsidiary industries in chemicals and the dyeing and finishing of cloth. Shipbuilding, which supplied oceangoing vessels for the substantial Indian Ocean trade, was likewise a major industry of traditional India. Indian shipwrights developed construction techniques especially suited to monsoon conditions of the Indian Ocean, and the importance of the Indian shipbuilding trade actually increased after Europeans entered those waters. Although iron smelting in India dates from 1000 BCE, it was practiced on a comparatively small scale until the Islamic Moghul empire and the advent of gun manufacture in the sixteenth century. The competence of Indian foundrymen is no better illustrated than by the commemorative iron pillar 24 feet high made at Delhi under Chandragupta II in the fourth century CE. (It reportedly shows no sign of rust even to this day.) Indian artisans also engaged in pottery-making, glass-making, and a myriad of other practical crafts befitting a great civilization. Given its technological complexity, India actually underwent an astonishing process of deindustrialization with the coming of formal British rule in the nineteenth century.

The caste system became more rigid in the Gupta period, with the definition of some 3,000 different hereditary castes. While the significance of the caste system for the history of technology in India was probably less than previously thought, the system remains noteworthy in that different technical crafts and craft traditions became socially separated into distinct castes and guild-like bodies, it being nominally forbidden to ply a trade outside of one's caste. Although caste barriers were sometimes breached, the separation of technology from scientific traditions is as evident in India as in China or ancient Greece.

A Hun invasion of Gupta territory in 455 CE proved disruptive, and a partial breakup of the empire ensued in the decade 480–90. Subsequent sixth-century Indian kings reestablished the empire, but the unity of classical Indian civilization collapsed completely in 647 after the death of the heirless king Harsha. A succession of minor Hindu states followed, and Islamic influences and incursions began to be felt in India after 1000 CE. Islam exercised wide appeal, in part because it repudiated caste divisions. An independent Delhi sultanate ruled over the

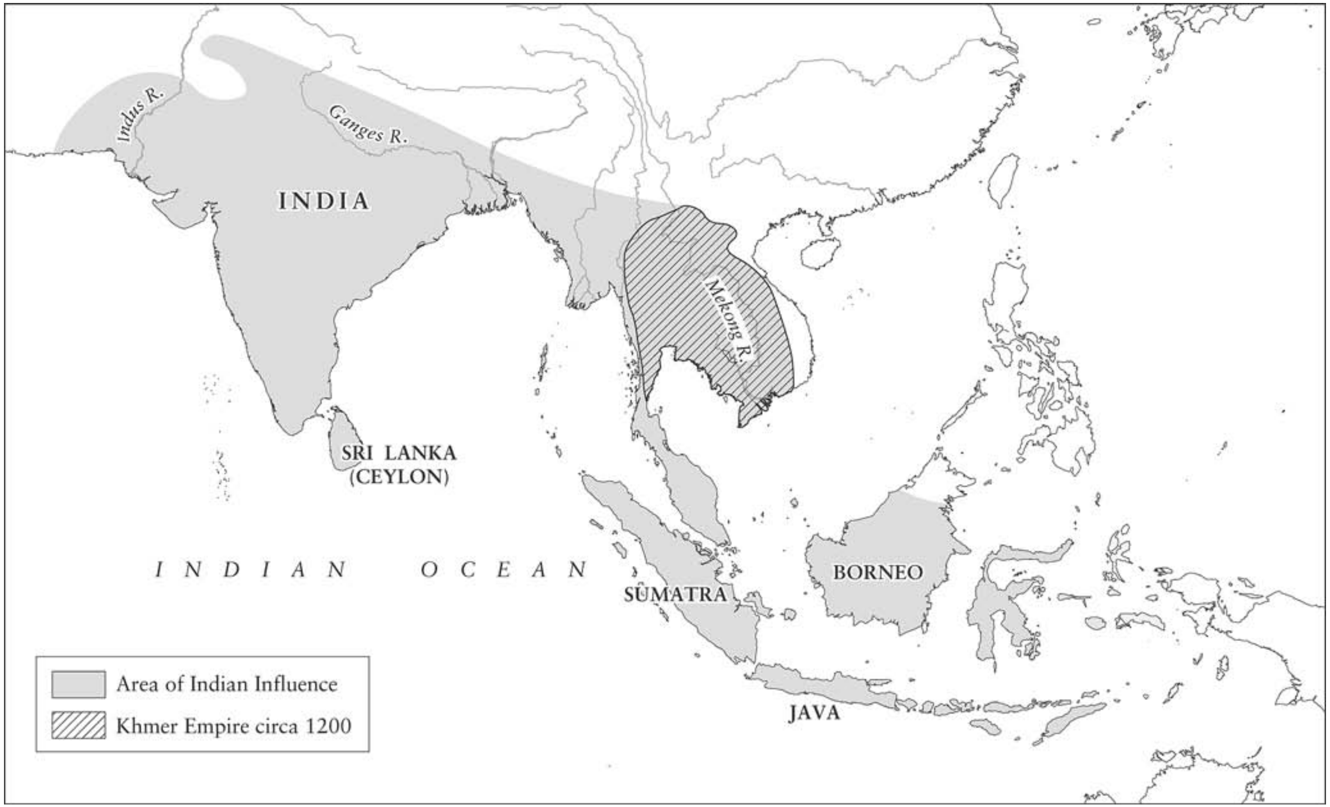
Indus and Ganges in northern India from 1206 to 1526, and, by dint of superior cannon technology, the Islamic Moghul empire governed North India from 1526 nominally to 1857. Muslim rule brought improved irrigation and hydraulic technology to North Indian agriculture, including the use of artificial lakes. The great Moghul emperor Akbar (1556–1605) established a special government canal department, and at the height of the Moghul empire, fully one-third of the water used for irrigation flowed in manmade canals. As part of the Islamic imperium, India also fully assimilated Islamic science, most visibly in the spread of Islamic astronomical observatories. The cultural and institutional success of Islam spelled the end of traditional Hindu science and learning in those areas touched by the teachings of the Prophet.

Traditional Indian culture continued in the non-Islamic south within the borders of states and wealthy cities dependent on intensified agriculture. The Chola kingdom, for example, flourished from 800 to 1300. Chola engineers built irrigation works on a huge scale, including the damming of rivers and the creation of an artificial lake 16 miles long. Bureaucratic supervision is evident in the special committees in charge of irrigation tanks. In Mysore in South India 38,000 tanks remained in the eighteenth century, and 50,000 tanks in Madras in the nineteenth. This tantalizing evidence notwithstanding, the major manifestation of centralized agriculture, science, and state patronage occurred not on the Indian subcontinent itself, but rather in the spread of Indian civilization offshore to Sri Lanka and to Southeast Asia.

Greater India

The correlations between science and hydraulic civilization are evident in the case of Buddhist Sri Lanka (ancient Ceylon). Founded by legendary “water kings,” a quintessential hydraulic civilization arose on the island after invasions from the Indian mainland in the sixth century BCE, and a distinctive Sinhalese civilization maintained itself there for 1,500 years. Using thousands of tanks and catchments to collect irregular rainfall, irrigation agriculture and grain production spread in the dry zone in the north of the island. The hallmarks of hydraulic civilization likewise appeared: centralized authority, a government irrigation department, corvée labor, agricultural surpluses, and monumental building, including shrines, temples, and palaces built with tens of millions of cubic feet of brickwork on a scale equaling that of the Egyptian pyramids. Large urban population concentrations inevitably followed. Indeed, the main city of Polonnaruwa reportedly ranked as the most populous city in the world in the twelfth century CE.

The details remain sketchy, but records indicate royal patronage of expert knowledge in ancient Sri Lanka for work in astronomy, astrology, arithmetic, medicine, alchemy, geology, and acoustics. A bureaucratic caste, centered on temple scholars, also seems to have existed,


Indus R.
Ganges R.
INDIA
Mekong R.
SRI LANKA
(CEYLON)
INDIAN OCEAN
SUMATRA
BORNEO
JAVA
Area of Indian Influence
Khmer Empire circa 1200

with the chief royal physician a major government figure. Following the pattern established in India by Aśoka, the state diverted considerable resources to public health and medical institutions such as hospitals, lying-in homes, dispensaries, kitchens, and medicine-halls. In all, Sri Lanka reveals a typical pattern of useful, patronized science.

From an early date in the first millennium CE Indian merchants voyaged eastward across the Indian Ocean. By dint of extensive trade contact and sea links to Sumatra, Java, and Bali in Indonesia and through cultural contact with Buddhist missionaries from Sri Lanka, a pan-Indian civilization arose in Malaysia and Southeast Asia. A third-century account by a Chinese traveler, for example, reported the existence of an Indian-based script, libraries, and archives in the Funan kingdom in what is modern Vietnam. Indian influence in the region increased in the fourth and fifth centuries. Brahmin from India were welcomed as local rulers bringing with them Indian law and administrative procedures. Sanskrit became the language of government and learned religious commentaries, while Hinduism and Buddhism coexisted as the dominant faiths.

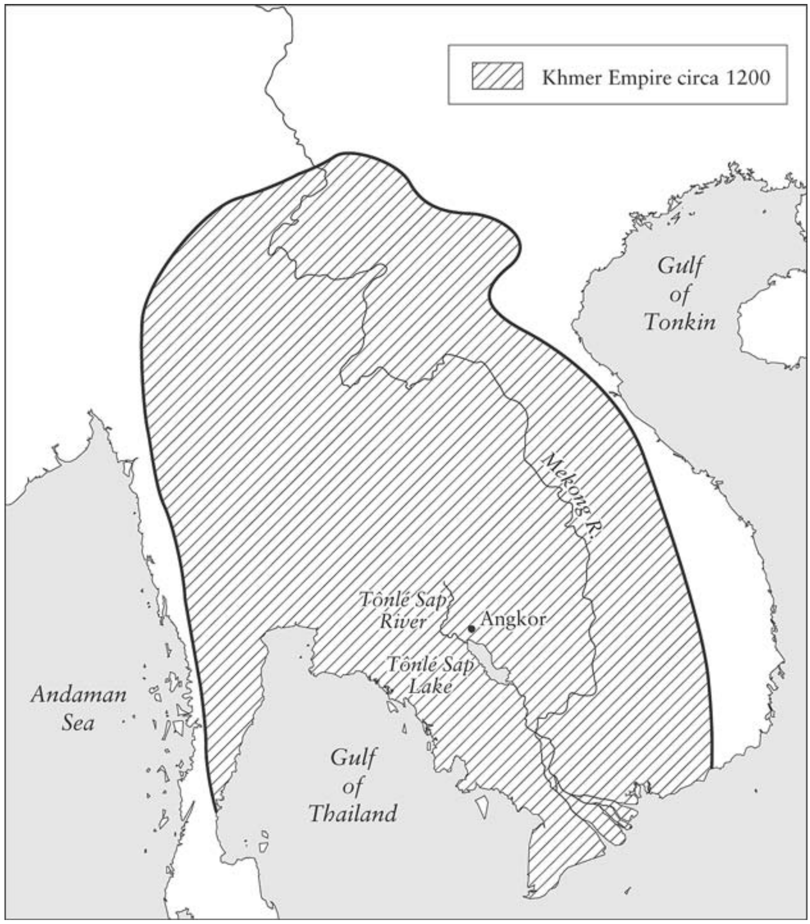
The great Cambodian or Khmer empire provides the most remarkable and revealing example of this extension of Indian cultural influence. A prosperous and independent kingdom for over six centuries from 802 to 1431, the Khmer empire at its height under King Jayavarman VII (r. 1181–1215) was the largest political entity ever in Southeast Asia, covering parts of modern Cambodia, Thailand, Laos, Burma, Vietnam, and the Malay Peninsula.

The Khmer empire arose along the alluvial plains of the lower Mekong River, and the great wealth of Khmer society derived from the most substantial irrigation infrastructure in Southeast Asian history. The annual monsoon flooded the Mekong and its tributaries, with the Cambodian Great Lake (Tônlé Sap) turning into a natural reservoir. Using impounded water techniques, Khmer engineers built an enormous system of artificial lakes, canals, channels, and shallow reservoirs with long embankments (called *barays*) to control the river system and to hold water for distribution in the dry season. By 1150 CE over 400,000 acres (167,000 hectares) were subject to artificial irrigation. The East Baray at Angkor Wat alone stretched 3.75 miles long and 1.25 miles wide. Hydrologic conditions along the Mekong were ideal for cultivating rice, that exceptionally bountiful crop that produced dramatic effects whenever it was introduced, as we saw in the case of China. Such a productive capability supported dense population concentrations, an immense labor force, and a wealthy ruling class.

Yet again social and scientific patterns associated with hydraulic civilization repeated themselves in the Khmer empire. Khmer kings, living deities like Egyptian pharaohs, exercised a strong centralized authority. A complex bureaucracy, headed by an oligarchy of learned Brahmins and military officers, ran the day-to-day affairs of the empire. One

Map 8.2. Greater India. An Indian-derived civilization arose on the island of Sri Lanka (Ceylon), and Indian-inspired cultures also developed in Southeast Asia, notably in the great Khmer Empire that appeared in the ninth century BCE along the Mekong River. *(opposite)*

Map 8.3. The Khmer Empire. Based on rice production and the hydrologic resources of the Mekong River and related tributaries, this Indian-inspired empire flourished magnificently in the twelfth and thirteenth centuries. Based on substantial irrigation and impounded water technologies, the Khmer Empire constituted the largest political entity in Southeast Asian history. It exemplified the typical trappings of high civilization, including monumental building, literacy, numeracy, astronomical knowledge, and state support for useful science. With the demise of its irrigation infrastructure Khmer civilization disappeared in the early fifteenth century.



source labels this bureaucracy a welfare state, perhaps because Jayavarman VII supposedly built 100 public hospitals. Various libraries and archives also testify to the bureaucratic nature of the state and of higher learning. In addition to irrigation projects and a highway system (with rest houses) linking various parts of the empire, Khmer royal power directed prodigious construction projects, notably in the capital district of Angkor, built up over a 300-year period. As an urban center Angkor covered 60 square miles and consisted of a whole series of towns along coordinate axes running 19 miles east-west and 12 miles north-south. Among the 200 temples in the region, each with its own system of reservoirs and canals of practical and symbolic significance, the complex at Angkor Wat is the largest temple in the world. Surrounded with a moat almost 660 feet wide, the temple is made of as much stone as the great pyramid at Giza, and with virtually every square inch of surface area carved in bas-relief. The complex itself was completed in 1150 CE, after fewer than 40 years of construction. Nearly a mile square, Angkor Wat itself contained twelve major temples, and its central spire soared to nearly 200 feet. Even more formidable, the magnificent administrative and temple complex at Angkor Thom, finished in 1187, enclosed a walled city of almost four square miles. Among their other uses, these great temples functioned as mausoleums for Khmer kings.

The Khmer court patronized science and useful knowledge. The court attracted Indian scholars, artists, and gurus, and with them Indian astronomy and alchemy came to Cambodia and Southeast Asia. Alongside ruling Brahmins and military leaders, a separate caste of teachers and priests plied their trades, teaching Sanskrit texts and training new generations of astrologers and court ceremonialists. The existence of Khmer "hospitals" suggests the organization of medical training and practice at a high level within the empire. The unity of astronomy, calendrical reckoning, astrology, numerology, and architecture is evident in the structure of Angkor Wat, meticulously laid out along lines dictated by Indian cosmology, with special moats and an architectural sacred mountain. Several of the thousands of bas-relief carved into the buildings indicate concern with elixirs of immortality. The complex

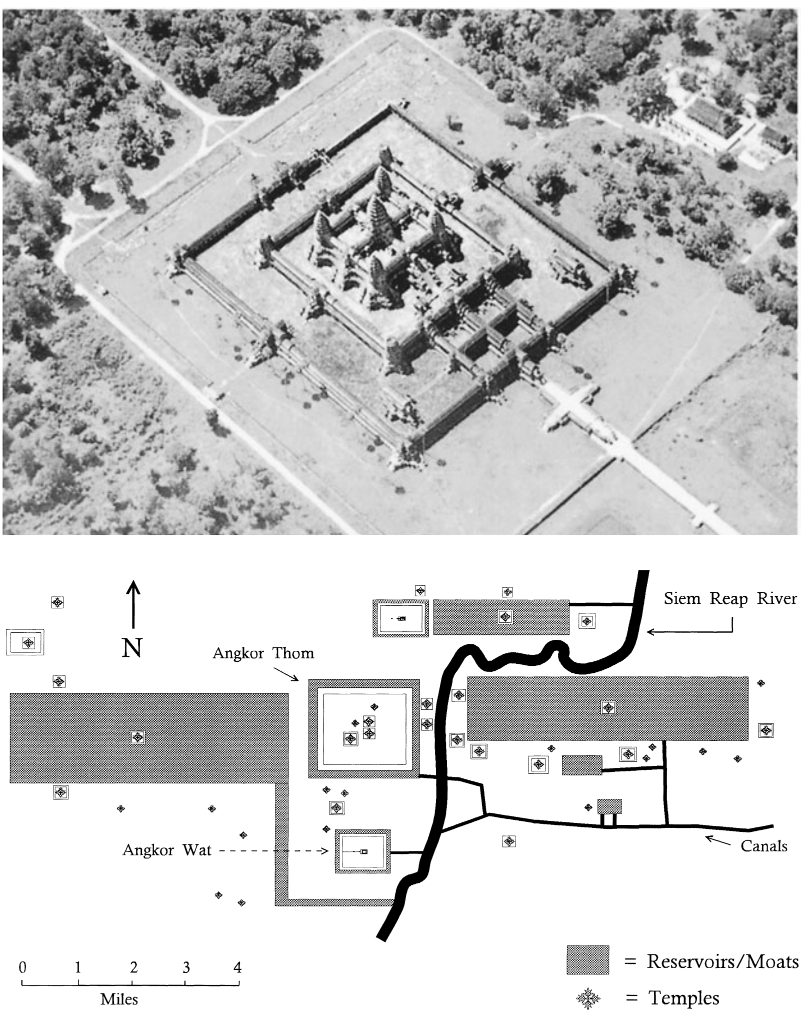


Fig. 8.1. Angkor Wat. Among the 200 temples in the region, each with its own system of reservoirs and canals, Angkor Wat is the largest temple complex in the world. Surrounded by a moat almost 660 feet wide, the temple is made of as much stone as the great pyramid at Giza, and virtually every square inch of surface area is carved in bas-relief. The complex was completed in 1150 BCE, after fewer than 40 years of construction.

also has built-in astronomical sight lines recording solar and lunar motion along the horizon. The spring equinox, which evidently marked the onset of the calendar year, receives special emphasis. Given these sight lines built into the monument, eclipse prediction is possible at Angkor Wat, but whether Khmer astronomers actually predicted eclipses is a matter of speculation.

Overbuilding may have exhausted the state and sapped the vitality of Khmer civilization. Beginning in the fourteenth century, the Khmer empire suffered repeated invasions from neighboring Thai and Cham (Vietnamese) peoples. These attacks destroyed the irrigation infrastructure on which Khmer civilization depended: maintenance activities ceased, war created damage, and demands for soldiers reduced the corvée. As a result, populations collapsed, and so did the Khmer empire itself. The Thais conquered; Sanskrit ceased to be the learned language of Southeast Asia; a new, less ornate style of Buddhism prevailed; and Angkor itself was abandoned in 1444, to be swallowed by the encroaching jungle. The French "discovered" and brought to the world's attention the ruins of Angkor and of Khmer civilization only in 1861. Although lost for four centuries, Khmer civilization testifies to the now-familiar pattern of agricultural intensification, bureaucratic centralization, and patronage of useful sciences.