India Is Ready To Fulfill Its Legacy of Leadership

by Ramtanu Maitra

India, the world's second-most populous nation, with over 1.2 billion people, is well situated to play a crucial role, in combination with fellow BRICS giants China and Russia, in carrying out the transformation of the world economy toward one of cooperation for dramatic scientific and industrial progress. While in urgent need of major modernization of its physical infrastructure—transport, power, and water, in particular—India, in the years since its independence in 1947, has developed in-depth capabilities in science, engineering, and agriculture, which will allow it to undergo a qualitative leap, once the political decision is made to do so.

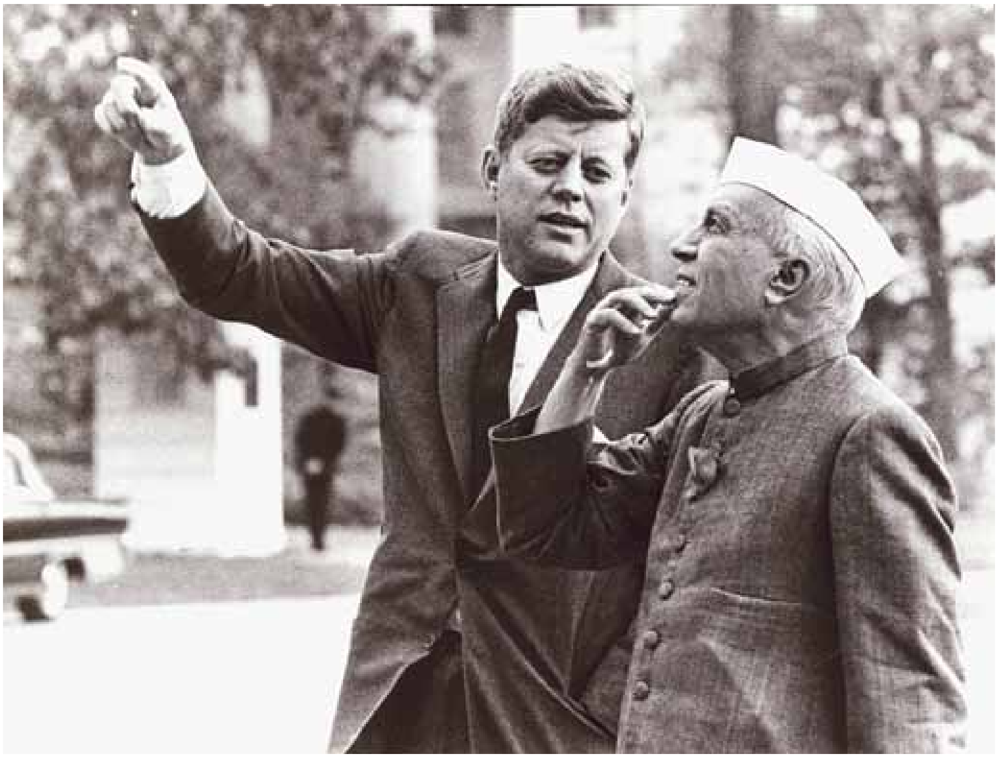
Once a proud leader of the Non-Aligned Movement, India has had the benefit of two extraordinary prime ministers, who had global vision and paved the way for the current opportunity. The first was Jawaharlal Nehru, the newly liberated nation's first prime minister, who established India's strong scientific and industrial foundation. The second was his daughter Indira Gandhi, who led a global battle of developing nations for a new, just world economic order in the 1970s and early 1980s, demanding technology transfer and justice for the poorer nations of the planet. Mrs. Gandhi additionally made the indispensable contribution of promoting the agricultural revolution that made India self-sufficient in food.

Since Mrs. Gandhi's assassination in 1984, India has generally played a lesser global role, and found itself faced with the increasingly dilapidated infrastructure now crippling its progress. But now, after ten years of insipid and self-confining economic policies led by IMF-World Bank-trained economists, India has a new leader, Narendra Modi. Modi, unlike his immediate predecessors, drew the electorate's attention during the 2014 parliamentary elections by promising large-scale infrastructure development in the coming years, to set the stage for future rapid progress in the industrial, manufacturing, and agricultural sectors, and thus to create millions of productive jobs for India's youth. He adjusted the pitch of his campaign to meet the expressed aspirations of hundreds of millions of young people who want to be part of the nation-building process, to unfold a brighter future for themselves and future generations. Having succeeded in conveying to the youth what he wants to undertake, Modi won the national elections in May 2014 with a large plurality, and has thus been entrusted with the task of delivering on his promises.

Modi, like many other Indians, realizes that the task is not going to be an easy one. The damage to the economy wrought by earlier administrations has created a deep rot within Indian institutions through which these tasks need to be carried out. In addition, the global economic downturn since 2008 has bankrupted potential investors from Europe and Japan. What is in Modi's favor, is 1) India's solid economic foundation, which was laid soon after it broke away from the British colonial grip and became an independent nation, and 2) the solidarity Modi shares with the BRICS nations [Brazil, Russia, India, China, South Africa], which are fighting to break free of the monetarist stranglehold.

Nehru's Contribution

Soon after India became independent, India's Prime Minister Jawaharlal Nehru did a few key things right. One of those was laying a strong foundation, geared towards adopting frontier science and technology, to build up the country's industrial and manufacturing base. Nehru understood the need to build India's physical economy and how important a role infrastructure plays in forging a highly productive economy. At the outset, Nehru realized that to provide a future for the multitude of present and future Indians, the nation must move away from the British-organized coolie-labor-based economy.


U.S. Embassy New Delhi

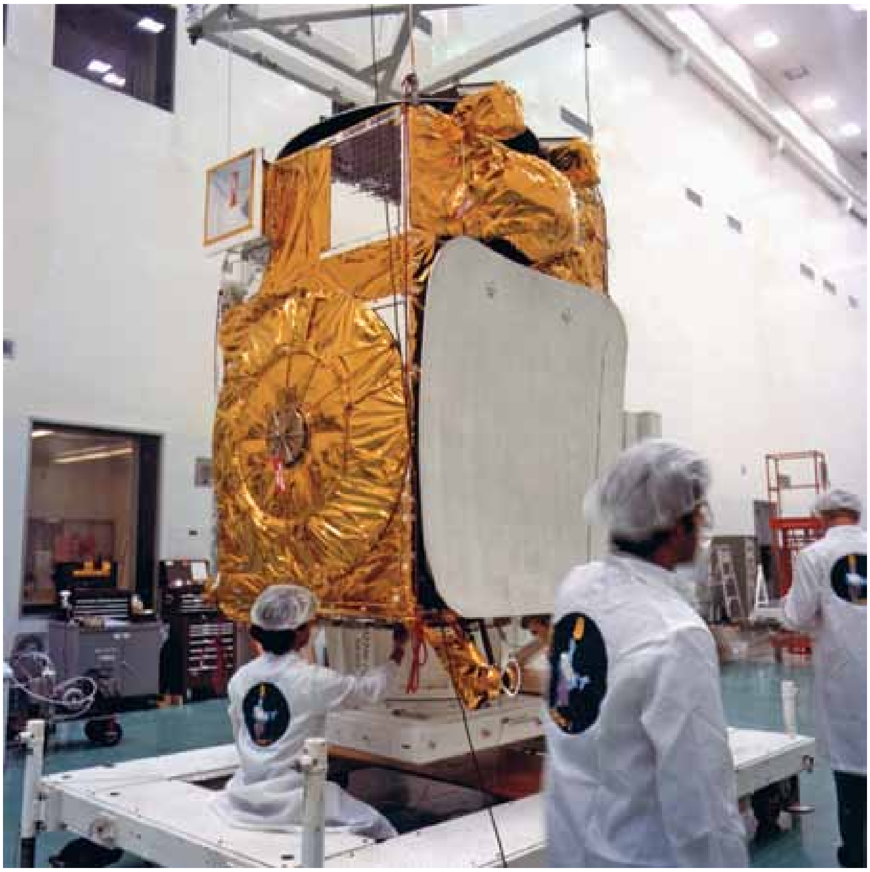
Jawaharlal Nehru, India's first prime minister, with U.S. President John F. Kennedy in Washington, 1961. Nehru did much to pave the way for India's scientific and technological progress, and its potential today.

With the help of a few brilliant and nationalist scientists, among whom Dr. Homi Bhabha and Prof. Shanti Swarup Bhatnagar stand out as the two best-known, Nehru began to lay the foundation for Indian science in general, and nuclear research in particular. While the fundamental research on nuclear science had already been started by Dr. Bhabha in 1945, in 1954, India set up the Atomic Energy Establishment, Trombay (AEET) with the intent to evolve a self-sufficient atomic energy program and to make the nation, eventually, power-independent. (The AEET was renamed the Bhabha Atomic Research Center in 1967, following Dr. Bhabha's mysterious death in 1966 on his way to an IAEA meeting in Vienna.)

In the late 1950s, Dr. Bhabha had laid out a three-stage atomic program, which has been pursued diligently since. India's atomic energy establishment is presently on the verge of entering the second stage, which features the use of breeder reactors. The third stage will be based entirely on the nation's vast reserves of thorium as fuel. An experimental and indigenously developed 300-MW thorium-fueled nuclear power reactor is scheduled for commissioning in March 2015 at the Kalpakkam nuclear plant complex in southern India.

For a number of reasons, India's atomic energy establishment has so far contributed only minimally to meeting India's huge power requirements. These reasons unfortunately include a concerted, decades-long effort by the developed countries to prevent India from importing nuclear-related equipment or material, and the inability of the Indian leaders, particularly those who were at the helm during the last three decades, to grasp the importance of Dr. Bhabha's vision. But decades of extensive research and development work by India's nuclear scientists have put India at the forefront in many aspects of atomic science, with manpower to match, and the country is now at the threshold of utilizing this infinite power source. It is the success of India's atomic sector in the coming years that will be the base upon which its vast industrial and manufacturing sector is established. It is now up to Prime Minister Modi to seize the hour.

India's promises to build an agro-industrial nation based on science and technology began with the Scientific Policy Resolution of 1958, which has come to be considered as a sort of Magna Carta for science and technology in India. The Resolution laid out New Delhi's commitment to the advancement of science. It said the key to national prosperity lies in industrialization, involving the combined roles of technology, raw materials, and capital, pointing out that "technology can only grow out of the study of science and its application." Taking note of the accelerated pace of the development of science in the 20th Century, the Resolution said that "it is an inherent obligation of a great country like India, with its traditions of scholarship and original thinking and its great cultural heritage, to participate fully in the march of science, which is probably man-



NASA/Wikimedia Commons

The Insat 1B is part of the Indian National Satellite System, a series of geostationary satellites commissioned in 1983. INSAT is now the largest domestic communication system in the Asia-Pacific region.

kind's greatest enterprise today."

The next step for developing the science sector was the establishment of the Indian Space Research Organization (ISRO) in 1969. Despite the country's financial and infrastructural weaknesses, India's space program is a huge success, ushering in a whole new set of technologies, materials for industrial use, spin-offs that range from polyurethane prosthetics to automatic weather stations, pressure transducers, and hundreds of other products. It has also created a brigade of scientists and technicians who are at the front line of space technology.

ISRO's first satellite, Aryabhata, was launched by the Soviet Union in 1975. Rohini, the first satellite to be placed in orbit by an Indian-made launch vehicle (the Satellite Launch Vehicle 3) was launched in 1980. ISRO subsequently developed two other rockets: the Polar Satellite Launch Vehicle (PSLV) for putting satellites into polar orbit, and the Geostationary Space Launch Vehicle (GSLV) for placing satellites into geostationary orbit. These rockets have launched communications satellites, Earth-observation satellites, and, in 2008, Chandrayaan-1, India's first mission to the Moon. On Nov 14, 2008, the Moon Impact Probe separated from the Chandrayaan-1 orbiter and struck the Moon's South Pole in a controlled manner, making India the fourth country to place its flag on the lunar surface. The probe impacted near the crater Shackleton, ejecting underground soil that could then be analyzed for the presence of ice (water).

India's first interplanetary probe has completed 300 days of its mission. The Mars Orbiter Spacecraft, which was launched on Nov. 5, 2013, was designed to orbit Mars in an elliptical orbit. ISRO plans to put two astronauts into Earth orbit in 2015.

It is expected that India's space program will receive strong support from the present administration, since Prime Minister Modi is a fervent backer and has suggested putting up satellites for the use of India's South Asian neighbors. Moreover, India's rockets have become the backbone of the military's defensive and offensive weapons systems.

India also has a significant nuclear fusion program. It began in 1989 at the Institute for Plasma Research in Gandhinagar, when India's first tokamak, called ADITYA, was commissioned. It was designed and mainly fabricated domestically, and has been upgraded several times. Currently, scientists are moving to the next phase, which is to build and operate the Steady State Tokamak, which will use superconducting magnets to produce a 3 Tesla magnetic field, and set the stage for commercial development of fusion.

Meanwhile, India is producing nine large components for the International Thermonuclear Experimental Reactor (ITER), amounting to almost a tenth of the project. The biggest of these is the cryostat, a 3,800-ton pressure chamber the size of a 10-story building, which will have to be shipped in pieces to ITER's site in France.

Mrs. Gandhi Defeats Famine

These are credible successes, made despite India's failure to build adequate infrastructure by keeping its focus on the maximization of energy-flux density. As a result of that failure, India has had a massive shortage in power generation, and the country was unable to manage the vast amount of water during the 13 weeks of monsoon that visits India every year, to inundate rivers, and flood cities and plains on its way to the sea. This failure gave rise to a famine-like situation in the mid-1960s.

Prime Minister Indira Gandhi

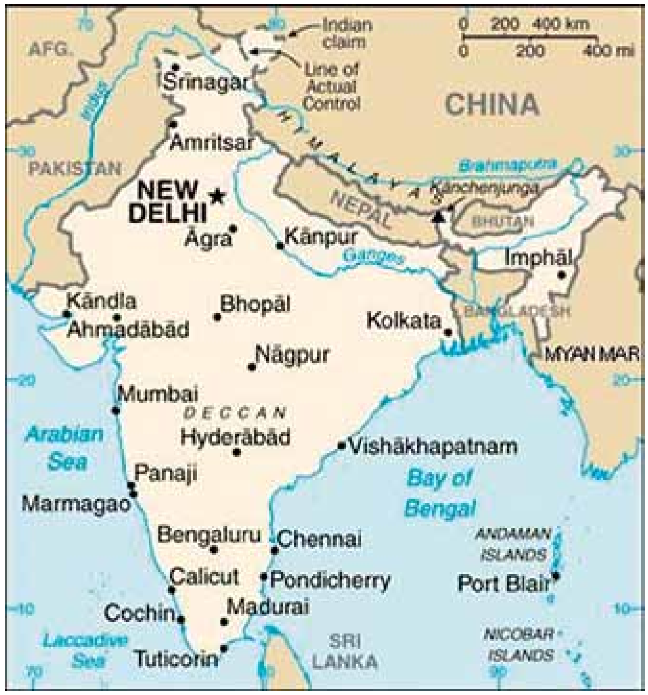
Under the tutelage of Indira Gandhi and two plant breeders—Norman Borlaug with wheat and M.S. Swaminathan with rice—the national government set up the logistics to encourage the planting of higher-yield varieties. Within a span of two decades, India, adopting high-yield variety seeds and fertilizers, using some irrigation and a large amount of groundwater, was transformed from a food-short nation to a food-surplus nation. This was enormously important for the country's political independence, and that commitment continues to be shown today by India's refusal to kowtow to the World Trade Organization on the question of its Food Security program. That single developmental surge focused on the agricultural sector allowed India to get set for speedy progress.

That, however, did not happen. India's agricultural sector, neglected for almost two decades now, is still far from achieving its potential. Failing to divert rivers with surplus water to water-short rivers during the last four decades has kept India's agricultural productivity way below that of Japan, China, or South Korea, to name a few, and its agricultural production remains highly dependent on the strength and timely arrival of the monsoon rains.

Heavy Engineering Powerhouse

Notwithstanding the developmental shortfalls, anchored on its weak and dilapidated infrastructure, India

FIGURE 1
India

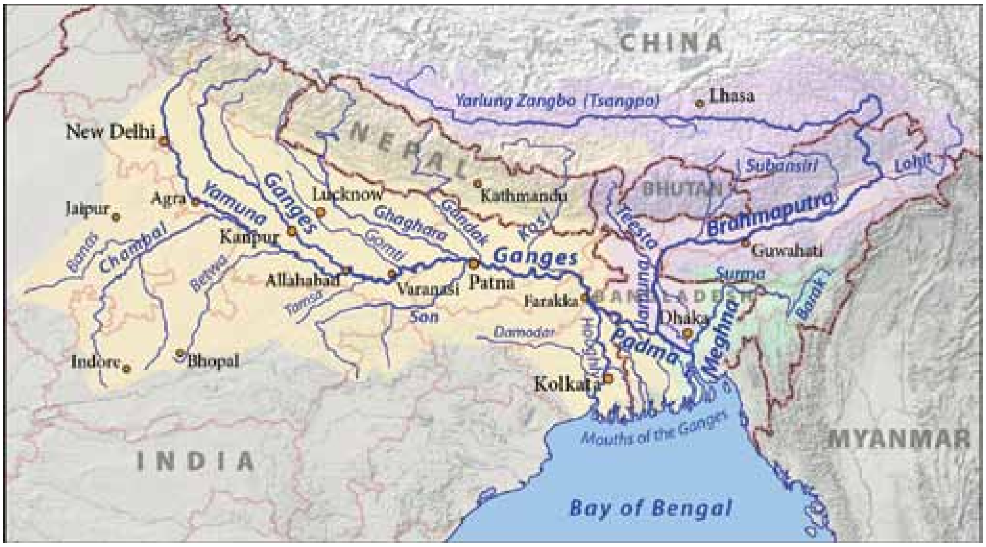


is in a position to advance rapidly in the agro-industrial sector. Its heavy engineering capabilities, the foundations of which were laid in the 1950s, as well as its technological capabilities and food self-sufficiency, make it ready to move rapidly forward.

For instance, India's heavy engineering capabilities are exhibited in its ability to manufacture its coal-fired power plant equipment. The country has built almost 3,200 large and medium-sized dams since independence, and manufactured the nuclear reactor core vessel of the pressurized heavy water and fast breeder reactors, made from stainless steel. It is also prepared to produce component modules for Westinghouse AP1000 reactors, and to cooperate with Russia's Atomstroyexport in building components for the next four VVER reactors at Kudankulam in the state of Tamil Nadu. India has also signed an agreement with GE Hitachi to construct complete nuclear power plants, including the supply of reactor equipment and systems, valves, and electrical and instrumentation products for the advanced boiling water reactors (ABWR)—a Generation III reactor.

India's Bharat Forge Ltd (BFL), a multinational company which claims to be among the largest and most technologically advanced manufacturers of forged and machined components, is said to be the world's second-largest forging company, and is extending its activities into the power sector. In 2008, it formed a joint venture with Alstom—a French-based multinational company—primarily for manufacturing state-of-the-art super-critical power plant equipment in India, though the enterprise may extend to nuclear applications. In January 2009, it signed a memorandum of understanding with France's nuclear company Areva for a joint venture in casting and forging nuclear components for both export and the domestic market.

FIGURE 2
The Ganges-Brahmaputra-Meghna Basins



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These capabilities did not emerge in a vacuum. India had long ago begun to develop its machine-tool industry. There are about 450 manufacturers that make complete machines or their components. There are 150 units in the organized sector (manufacturererers that are registered with state governments, and therefore regulated). Almost 73% of the total machine-tool production in India is contributed by 10 large companies. The industry employs a workforce directly or indirectly totaling 65,000 skilled and unskilled persons. Similar insufficient, but growing, strength is reflected in the shipbuilding and defense sectors. India has 37 shipyards, four of the major ones are in the public sector, and have a maximum capability to build 50,000 deadweight tonnage (DWT) ships.

In the defense sector, the Indian Navy plans to expand to a fleet of 150 ships in the next 10-15 years, with 50 warships now under construction and 100 vessels in the acquisition pipeline.

Infrastructure Needs

As we have indicated, the blockage to full development based on this solid foundation is the lack of modern infrastructure in water, power, and transportation—infrastructure that would not only enhance the national economy, but permit an efficient linkup with both the New Silk Road and the Maritime Silk Road. Indeed, *EIR* pointed out more than three decades ago, in its report *India: An Agro-Industrial Superpower in 2020,* that modernizing infrastructure was the single most critical ingredient for allowing India to fill the gaps in its economy.

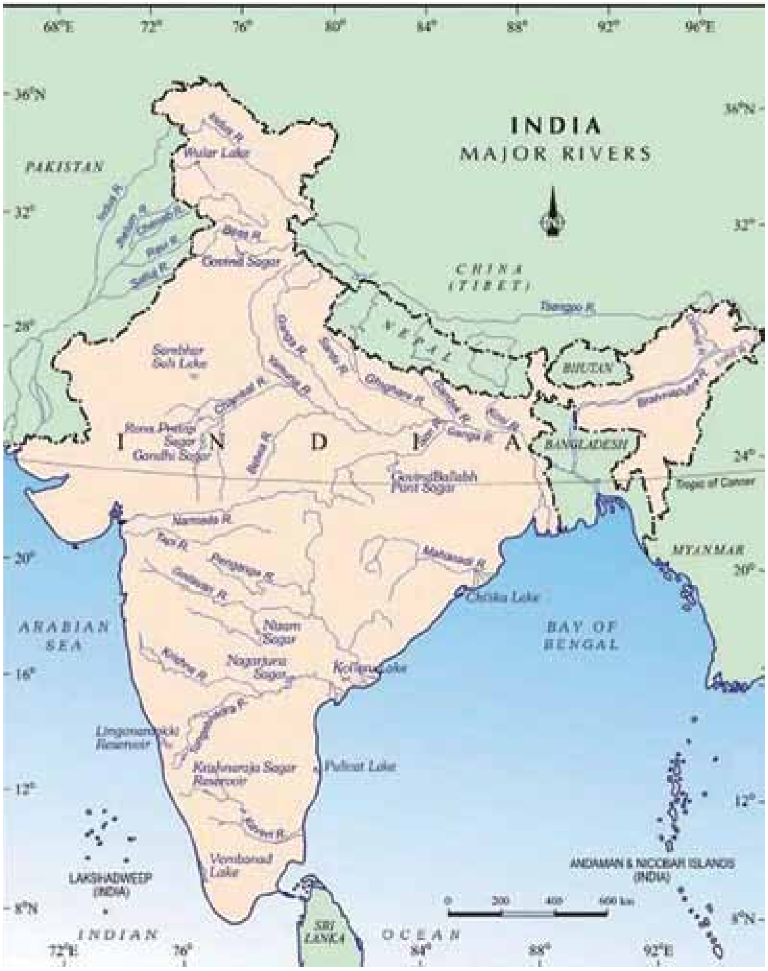
The following are the major development corridors that *EIR* has identified as crucial for India's rapid development, and integration with the region's development perspective:

1. A northeast economic corridor, which will consist of a high-speed rail link from the Myanmar border through Dangari (India) and Tamu (India) in the central part of India's border with Myanmar, to the port of Kolkata in the southwest and Patna in the east. India is in the process of building the Jiribam-Imphal-Moreh line in the east Indian state of Manipur and the Tamu-Kalay-Segyi line in Myanmar. The northeast transport corridor needs to be linked to the Jiribam-Imphal-Moreh line.

The economic corridor, which will be supplanted with the Kunming-Kolkata Highway, will broaden a segment of the Silk Road, linking Yunnan to Kolkata, an essential element in the development of the area.

Water will be available aplenty from the Brahmaputra River Basin (**Figure 2**). What the area needs beside a transport corridor is nuclear power. A number of nuclear power plants in clusters need to be set up to supply agro-industrial complexes and centers of primary, sec-

FIGURE 3



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ondary, and higher education, health-care facilities with research capabilities, and heavy-engineering manufacturing centers.

2. A Kolkata-Delhi high-speed transport corridor and an economic corridor. This is under discussion with Japan, which has already begun work on the Delhi-Mumbai high-speed (bullet train) transport corridor, and New Delhi has begun acquiring land (50 miles wide on either side of the corridor) to establish the Delhi-Mumbai economic corridor. A similar swath of land will be required for the 900-km Kolkata-Delhi economic corridor.

3. India will need two more high-speed transport and economic corridors, from Kolkata to Hyderabad, and from Hyderabad to Chennai. Along these corridors, plants supplying 15-20,000 MW of nuclear power have to be built. Both these corridors will encounter water shortages and will require reviving the old Peninsular River linking plan.

4. In order to make these economic corridors fruitful, long-distance transfer of water from water-surplus basins to water-short basins will be needed. India has two sets of rivers (**Figure 3**). The Himalayan rivers originate in the mountains and flow through the Northern Plains, e.g., the Ganga, the Yamuna, and their tributaries. The second category of rivers is known as Peninsular Rivers, which originate in the Western Ghats mountains. They have a large seasonal fluctuation in volume as they are solely fed from rainfall. These rivers flow through valleys with steep gradients. Major rivers of the Peninsula, such as the Mahanadi, Godavari, Krishna, and Cauvery, flow eastward on the plateau, and drain into Bay of Bengal. The Narmada and Tapti rivers flow eastward. The Narmada rises in the Amarkantak plateau in the state of Madhya Pradesh and enters the Gulf of Cambay in the Arabian Sea.

The interlinking of the Mahanadi-Godavari-Krishna-Pennar-Cauvery rivers is one of the four parts of the Peninsular River Development Plan. Among the peninsular rivers, the Mahanadi and Godavari have sizeable surpluses after meeting immediate and known future requirements. It is therefore necessary to transfer surplus Mahanadi-Godavari water to the water-short Krishna, the Pennar, and the Cauvery. But the canal system that will carry the water from one basin to another may not meet the overall requirements of these two economic corridors.

Since these economic corridors are not at a great distance from India's east coast, desalination will have to fill the deficit. It could produce a reliable supply of freshwater. India has begun looking at the use of nuclear power for desalination of seawater. A desalination demonstration plant at Kalpakkam, using nuclear waste heat for the multi-stage flash process that produces 4,500 cubic meters per day, has already been set up. These plants can be scaled up 10 times from the present configuration without any difficulty, according to one expert. Two methods of desalination—reverse osmosis and multi-stage flash—have been demonstrated at the Bhabha Atomic Research Center.