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China's magnificent high-speed rail system

By Michael Billington. Reprinted from Executive Intelligence Review, *23 March 2018.*

19 Mar.—That China has the most advanced and most extensive high-speed rail system in the world is well known. The Chinese system originally gained support and technology from Germany's Siemens, France's Alstom, Canada's Bombardier, and Japan's Kawasaki, but is now producing its own train sets of the highest quality. What is less well known are the numerous ingenious systems China has developed *de novo* in order to become the world leader in rail technology, and by far the largest and fastest producer of high-speed rail in the world. This includes production technologies, testing technologies, construction techniques, machinery, and more.

It is difficult to overstate the amazing scope of the system. As of early 2018, China has constructed 22,000 km of domestic high-speed rail track, which is nearly double the total for the rest of the world combined. Not a single kilometre of rail in the United States would be counted as "high-speed" by China's standard—minimally 250 km/h. (The Acela Express on the US Northeast Corridor has a maximum speed, seldom attained, of just under 250 km/h.) New high-speed rail is coming on line in China at the rate of 2,000 km per year.

Top: A high-speed train in China's Guangxi Zhuang Autonomous Region. Above: High-speed train in an urban setting in China. Photos: Xinhua/Wei Wanzhong; Courtesy of China Railway

The fastest passenger train in the world, which also carries the most passengers per year, is the Beijing to Shanghai line. At 350 km/h, it carries about 6 million passengers per year. The longest high-speed line in the world, to be completed in 2018, will run 2,230 km from Beijing to Guangzhou and Hong Kong.

The Beijing-Shanghai line was restricted to 300 km/h after a major high-speed rail accident in 2011 in Wenzhou, Zhejiang Province, which killed 40 people and forced a re-evaluation and upgrading of the entire national system. In June 2017 the train sets running on the Beijing-Shanghai line were replaced by a higher standard system, fully designed and produced within China, called Fuxing (Rejuvenation), replacing the Hexie (Harmony) trains which were commissioned in 2008. In early 2018, the speed limit for this line was raised back to 350 km/h, and could eventually be raised to

Chinese maglev factory underway

On 11 January 2018 China Railway Construction Corporation began building an industrial complex to include a 5.4 km maglev test line and a factory to build parts for maglev trains. Located in the city of Changsha in Hunan province, when completed the facility is expected to have an annual output worth US$1.5 billion. China's first maglev line between Pudong airport and central Shanghai was built with German technology, but a second low-speed maglev line, which opened in November 2016, was built with Chinese expertise. With its Belt and Road Initiative in its fifth year, no doubt China hopes to share this technology more broadly.

400 km/h, making the 1,318 km trip in just over three hours.

As recently as the 1990s, the average speed of China's trains was less than 60 km/h. A high-speed line from Lanzhou in Gansu Province to Urumqi in the far western Xinjiang Uygur Autonomous Region was opened in 2014, reducing the travel time from 21 hours to ight. Together with the New Silk Road Economic Belt, connecting China through Central Asia to Europe and Southwest Asia, this modern fast rail system has facilitated the development of the vast, under-populated far west regions of China, just as the opening of the first rail connection to Lhasa in 2006 facilitated the economic development of Tibet.

The line to Urumqi passes through multiple extremes of weather conditions, from broiling desert to snow-capped mountains—an 80 °C temperature differential, which required the development of new materials and machinery. It also passes through the "hundred-*li* wind zone" in Shanshan, part of the Taklamakan Desert in Xinjiang, where desert winds blow almost every day of the year. They even knocked over a train in 2007. A 462 km wind-protection barrier was constructed next to the tracks of the high-speed line as it passes through the Gobi and Taklamakan desert regions.

The high-speed routes are only one-sixth of the total rail track in the country, but already they carry 60 per cent of the passengers. The original plan, called 4+4 for four north-south routes and four eastwest routes, is essentially complete as of the beginning of 2018. Now in the planning stages is an 8+8 system.

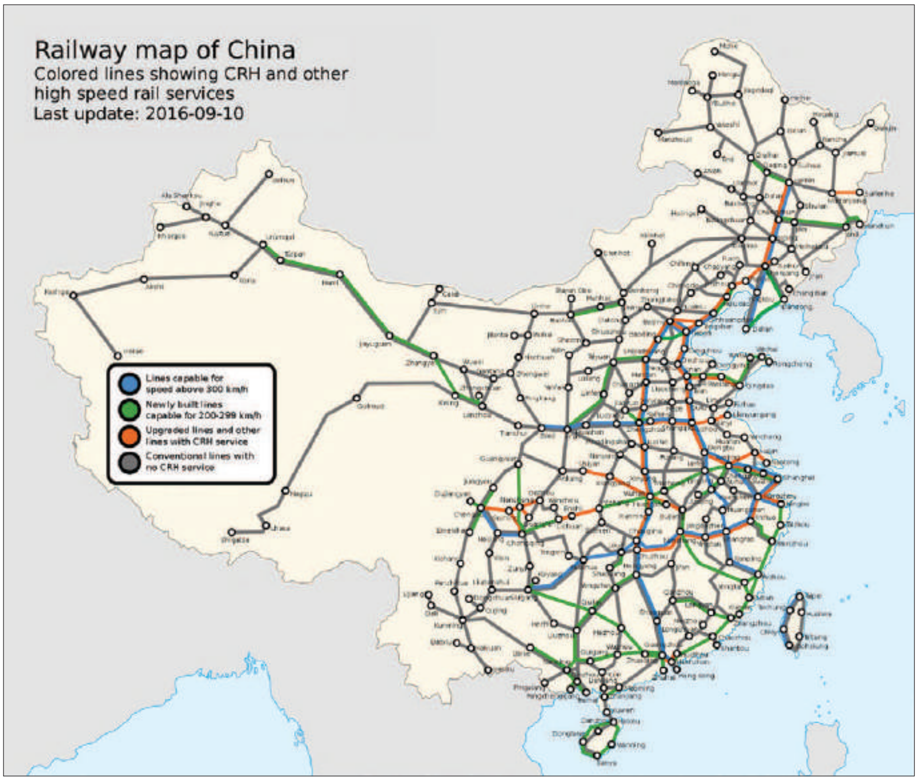


Photo: cc/Howchou

Machine in China enabling rapid placement of elevated trestles.

Financing the system

Only a few of the high-speed routes are currently profitable. Although over time that will change, it is not the top priority. Keeping prices reasonable to facilitate travel for all, to "serve the people", is far more important to the government. During the Spring Festival, the 40-day period in which millions of Chinese return to their home towns, 385 million people were travelling in China, many on the high-speed rail lines.

But it is also true that this system creates a dramatic boost in the productivity of the Chinese workforce due to enhanced mobility, which more than makes up for the lack of short-term profits for the fully government-owned system.

The famous magnetic levitation system which now connects Shanghai to its airport in Pudong using a German design—the only commercially active maglev in the world—has not been dramatically expanded for intercity travel as was once considered, but maglev is now being deployed for lower-speed intracity transit, using a system entirely developed within China.

Innovation in every aspect

A 50-minute documentary produced in October 2006 by China's CCTV on the high-speed rail system provides a fascinating look at the many levels of innovation that are the basis of China's world leadership in high-speed rail (www.youtube.com/watch?v=_THGI-7p3BPw).

In order to pass over many rivers and canals, and through many cities, especially on the densely populated eastern coast rail routes, it rapidly became apparent that, in many cases, nearly the entire route would need to be constructed on viaducts rather than on the ground.

China's magnificent high-speed rail system

Top: Danyang-Kunshan Grand Bridge in China. Middle: High-speed train in China. Above: High-speed trains in Wuhan prepared for the Spring Festival rush. Photos: YouTube; Xinhua

An ingenious machine was designed to place each bridge span into place on the pillars for these viaducts, vastly reducing the time for construction. See it at work in the above link to the full video, or watch this five-minute excerpt at www.highways.today/2016/07/04/how-china-is-building-its-bridges.

The Beijing-Shanghai line includes the longest bridge in the world, the Danyang-Kunshan Grand Bridge, passing over land and water. It is a 164.8 km viaduct constructed with the machine described above, including a 9 km section across Yangcheng Lake in the beautiful city of Suzhou in Jiangsu Province.

The required smoothness of the rails for high-speed rail is far greater than for regular trains, as the speed intensifies the impact of any imperfection. To make virtually seamless rail, 12 welding facilities were constructed across China, which bring in 100-metre-long rail sections (eight times longer than traditional rails), welding five of them together by robotic welders to near-perfect smoothness. The 500-metre rails are then lifted by 36 synchronised cranes onto special trains and delivered to the construction sites for the final welding.

Testing facilities for various aspects of the highspeed trains also required innovation. In addition to wind tunnels to test for aerodynamics, a system for testing the wheel and rail quality was constructed using a 10-tonne, three-metre diameter steel flywheel to test the wear on wheels and rail at 500 km/h. The CCTV video describes the facility as the "most advanced testing equipment for high-speed trains in the world".

At another site, another large steel flywheel was constructed to test different qualities of metals to be used for the pantographs—the jointed framework above the train which conveys the electric current from overhead wires at speeds up to 500 km/h.

And, described as the most secret of the innovations for the system, a "clean room" was constructed with a maximum of 10 mini-particles per cubic metre of air. In these rooms are produced the complex computer chips which run the trains and connect all the trains in the entire system to control centres.

The Belt and Road

China's world leadership in high-speed rail is not being kept for itself. As part of the Belt and Road Initiative, China is actively constructing or planning high-speed rail lines, as well as traditional rail lines, around the world. Laos, Thailand, Indonesia, Kenya, and Ethiopia already have systems in use or under construction. Trans-continental rail lines are in active planning stages in Africa and South America, as well as rail connections between the major cities in each of these two continents, ending the European colonial policy, which only built rail lines from the mines to the ports to extract raw materials, while leaving the countries themselves undeveloped and unconnected to each other. The Chinese saying, "If you want to be rich, first build a road", characterises their new paradigm approach: build the infrastructure as the necessary base for development. The proof is there for all to see in China.

A great railway boom

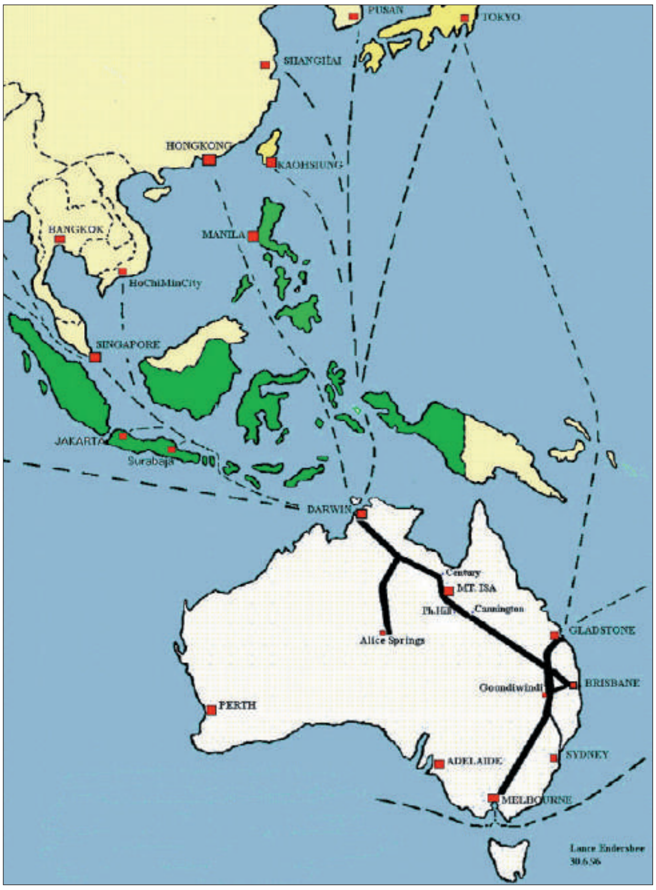
From "Australia's Blueprint for Economic Development", New Citizen, *Vol 5 No 6, April 2006. Originally printed Feb. 2002*

Australia's rail sector must be revolutionised, both for the sake of transport within our country, and also to tie Australia into the rest of the world, in particular into the world's greatest population centres, at the eastern and southeastern Asian terminals of the Eurasian Land-Bridge. This revolution will have two axes: Prof. Lance Endersbee's proposal for a Melbourne-Darwin Asian Express, and a vast upgrading and expansion of Australia's rail network centring upon the new magnetic levitation (mag-lev) rail technology pioneered in Germany, and which is now being built in China.

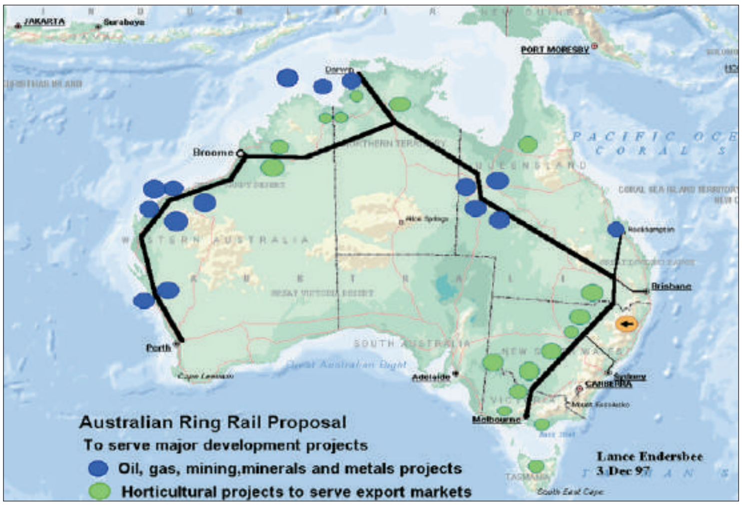
Our nation's rail sector at present is a pathetic shambles, so bad that the 2001 Australian Infrastructure Report Card prepared by the Institution of Engineers, Australia, a very conservative, understated body, rates it at D-, with the crucial Melbourne-Sydney-Brisbane rail corridor rating an F, due to "poor track co-ordination, steam age alignments and inadequate signalling and communications systems."

With the exception of rail lines built expressly to service mineral deposits, most of Australia's rail system was built at the turn of the 20th century. The report of the federal Parliament's Standing Committee on Communications, Transport and Microeconomic Reform, *Tracking Australia* warned in 1998, "Without urgent and substantial investment in this infrastructure, major sections of the national rail network are likely to become irretrievable within ten years. In this context, the rationale for increased investment in rail infrastructure has to be about averting the potentially enormous costs of diminished or defunct rail services between major cities on the eastern seaboard, including increased road construction and maintenance, and the negative externalities associated with large and growing volumes of road traffic."

That report was written three years ago. Under privatisation and competition policy, with the exception of the beginning construction of the Alice Springs-Darwin railroad, the rail system has not improved significantly since. The "negative externalities" in the report refer to the horrible figure of $15 billion per year lost in road accidents on overcrowded, deteriorating roads along with an estimated $13 billion annual loss due to congestion, which is expected to rise to $30 billion by 2015. Only a tiny fraction of the nation's passenger traffic moves by rail, and, since 1975, rail's share of interstate non-bulk freight has declined from 60 per cent to 35 per cent, even as the trucking industry is suffering record rates of bankruptcies and psychological and health problems associated with horrific working hours. Between 1975 and 2001 the Federal Government spent $43 billion on roads and a miniscule $2 billion on rail, even though for medium and long distance, rail is an inherently much more efficient mode of transport. Therefore, we must plan to spend some tens of billions on the industry over the next ten years, both in upgrading existing lines, but in particular in building the Asian Express and a maglev grid tying together all of our major population centres.



Prof. Endersbee's Asian Express, a high-speed train from Melbourne to Darwin, our gateway to Asia, would revolutionise Australia's export potentials.



The railways planned for Australia will not merely be transport systems, but 100 km wide "development corridors", encompassing oil and gas pipelines, communications networks, superhighways, agro-industrial complexes and new cities—as envisioned in Prof. Lance Endersbee's Asian Express and Ring Rail (above) proposals.

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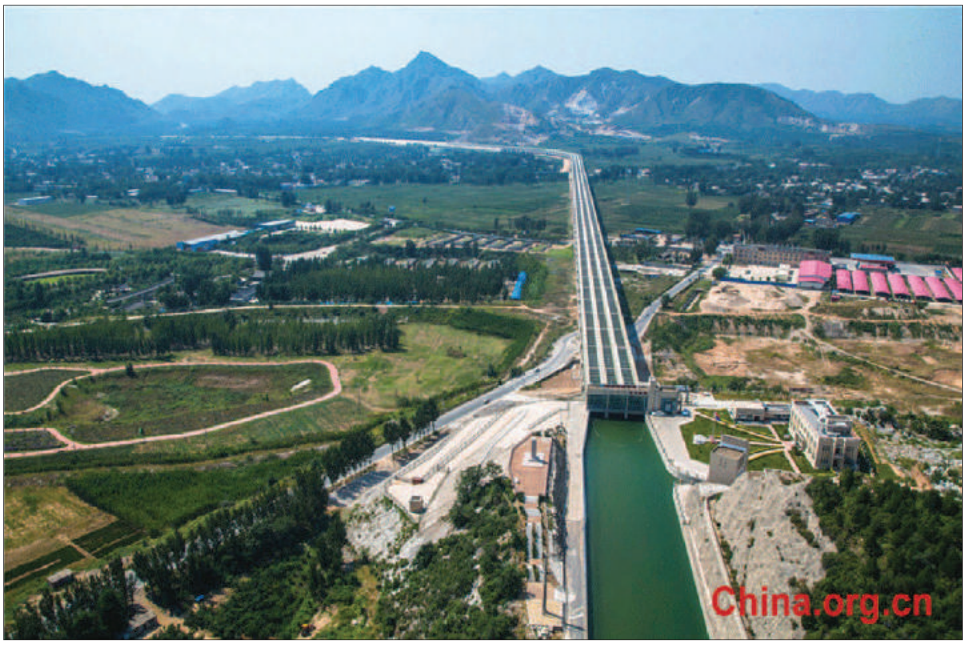
Moving water: By land and by air

By Mike Billington. Reprinted from Executive Intelligence Review, *9 March 2018.*


The Caohe River Aqueduct. Photo: china.org.cn

5 Mar.—China's water problem is in one sense the opposite of that in the United States. In North America, the northwest regions of Alaska and Canada's far west receive an abundance of precipitation, while the US southwest and northern Mexico are water-starved. It is the opposite in China—the southeast region in the Yangtze River basin has abundant fresh water resources, while the northeast, which holds a large portion of the nation's population, industry, and arable land, is desperately short of water.

But the big difference is that China is dealing with this imbalance, by moving water from the south to the north, while the United States has done nothing to resolve its problem, and thus suffers periodic droughts, resulting in recurring economic and social disasters. The North American Water and Power Alliance (NAWAPA), promoted by President Kennedy, would have moved Alaskan water south to the West and Southwest of the United States, and into northern Mexico—it would have been the largest infrastructure program ever undertaken by mankind. But like most large-scale scientific and infrastructural projects in the United States, NAWAPA died with JFK and his brother.

China, on the other hand, has unleashed the most massive water-moving program in human history, which is already partially in service and doing its job on behalf of current and future generations. The South-North Water Transfer Project (SNWTP) is China's multi-pronged Great Project to move water from the Yangtze River in the South to the Yellow River region in the North. Mao Zedong set in motion a feasibility study for such a project during a tour of the Yellow River region in 1952. It took 50 years until the plan was launched in 2002.

There are three canal routes which, when completed, will together move 44 cubic km/year of water to the North. For comparison, the Yangtze disgorges on average nearly 1,000 km^3/yr into the East China Sea, while the Yellow River's average is only 8 km^3/yr. The severity of the water crisis in Beijing, with a population of 24.9 million in its metropolitan area, is such that the huge amount of water to be transferred by the


Central route starting-point Taocha in Xichuan County, Nanyang, Henan Province. Looking "upstream", towards the Danjiangkou Reservoir. Photo: china.org.cn

Moving water: By land and by air

South-North Water Diversion Project

At time of completion, the three-route project will channel 44.8 billion cu m of water from the Yangtze River to the drought-stricken north China.

The Eastern Route links a string of lakes with the northern section of the Grand Canal and diverts 14.8 billion cu m of water annually.

The Central Route will divert 13.0 billion cu m of water annually. It will submerge 370 sq km of land and require the relocation of 330,000 people in Henan and Hubei provinces.

The Western Route will divert 17.0 billion cu m of water annually from the upper reaches of the Yangtze River to the Yellow River.

Sources: Chinese Ministry of Water Resources; futuretimeline.net; Will Fox

SNWTP will only meet about one third of the need for this rapidly growing region. Other means, including massive desalination plants, are also being developed.

The total combined length of the planned canals, is nearly 4,350 km, the approximate distance from New York to Los Angeles. The three routes are:

- The *Eastern Route* which follows the ancient Beijing-Hangzhou Grand Canal route, which was built between the 5th century BC and the 6th century AD to carry grain from the South to the North. When completed, the Eastern Route will deliver 14.8 km^3/yr of water from the Yangtze River, near its point of discharge into the East China Sea, north to Tianjin, 108 km southeast of Beijing. The Eastern Route was partially opened in December 2013. Pumping stations move the water along the uphill route, while a tunnel carries the water under the Yellow River, and from there, an aqueduct carries the water to reservoirs near Tianjin.
- The *Central Route*, completed in December 2014, moves water from the Han River tributary of the Yangtze, from a reservoir at Danjiangkou in Hubei Province, to the capital of Beijing and nearby Tianjin. The existing dam at Danjiangkou was raised by 13 meters, allowing the water to flow downhill into the canal, and then flow through the 1,400 km route to Beijing entirely by gravity. This is the longest canal in the world, although the planned canal to move water from the Congo River to replenish Lake Chad in the African Sahel will be still longer, at 2,500 km. (A feasibility study for the Lake Chad project is being conducted by Italy's Bonifica SpA and China's PowerChina.)

  The initial flow through the Central Route provides 9.5 km^3 to Beijing annually, but this will increase to 13 km^3 by 2030. Twin tunnels carry the water under the Yellow River. About 330,000 people were resettled from the region of the expanded Danjiangkou Reservoir and from along the route of the canal. A "green belt" is being built along the entire route to reduce pollution from local industry and agriculture. There is also a tentative plan to move water from the Three Gorges Dam Reservoir by canal to the Danjiangkou Reservoir, to increase the flow northwards without undermining the industries and agriculture which depend on the water of the Han River.
- The *Western Route* will consist of three canals moving water from the headwaters of the Yangtze in the Qinghai-Tibetan Plateau and western Yunnan Plateau, to the headwaters of the Yellow River. Crossing the divide between these two watersheds in this mountainous region will be a huge engineering feat, which is still in the planning stage. When completed, these canals will transfer 17 km^3 of water to the Yellow River, expanding its flow to the Yellow Sea.

The Qinghai-Tibetan Plateau is known as *Sanjiangyuan*, i.e. "The Source of Three Rivers" (the Yangtze, the Yellow, and the Mekong). Also originating in southwestern China are the Brahmaputra and the Salween. Plans have been sketched out to transfer water to the North from the headwaters of the three rivers which flow out from China—the Mekong, the Brahmaputra, and the Salween—which flow through India, Bangladesh, Myanmar, Laos, Thailand and Vietnam. But these are long-term plans at best, and would require agreement from the other nations. The completed Central Route is an engineering miracle—one of many

Left: The Danjiangkou Dam in Hubei Province. Right:The head of the middle route of the South-North Water Diversion Project. Photos: china.org.cn

Left: The exit of the Qilihe Canal Inverted Siphon Project. Right:The Xiheishan flow division gate. Photos: china.org.cn

Left: The Longquan Bridge in Shijiazhuang, capital city of Hebei Province. Right:The landscape bridge in Xingtai, Hebei Province. Photos: china.org.cn

Water tunnel of 600 km, under construction in Yunnan, is part of a pilot project to test technical capabilities to construct the Tibet-Xinjiang tunnel. Photo: Wikimedia commons

miracles which are becoming common occurrences these days in China. Its water passes through tunnels dug under four rivers, and over the Caohe River Aqueduct in Henan Province, which is one of the "longest and most sophisticated ever built", according to a CCTV report. The water enters Beijing through a 9 km tunnel flowing 15 storeys below ground, before finally being pumped into a new reservoir near the Summer Palace.

New miracles in the works

Two other projects are in the planning stages which can be considered part of the South-North transfer project. One is the Tianhe (Heavenly River) Project. Wang Guangqian, the president of Qinghai University and a member of the Chinese Academy of Sciences, is leading a team studying means of moving water in the atmospheric boundary layer and the troposphere, from above the headwaters of the Yangtze, north towards the headwaters of the Yellow River, and then provoking precipitation. The process is expected to move 5 km^3 of water into the North via the Yellow River annually.

A 45-minute video presentation titled "China's 'Heavenly River', the Future of Water", by the LaRouche PAC science team, is available at https://youtu.be/95N35ETWGnk.

A second project is directed at the vast arid regions of the far west of China, in the Xinjiang Uyghur Autonomous Region. The idea is to build a series of tunnels and waterfalls, bringing water from the Qinghai-Tibetan Plateau to Xinjiang. The engineers working on the project call it the "Turning Xinjiang into California Project". Central California, once a desert, became America's breadbasket when the Central Valley Project, launched under Franklin Roosevelt in 1933, moved water from northern California to the San Joaquin Valley.

The proposed project would transfer water from the Yarlung Tsangpo River in Tibet (known as the "water tower of Asia"), through a series of tunnels and manmade waterfalls, to green part of the Taklamakan Desert in Xinjiang. The project would require large dams and pumping stations as well as tunnels, and would pose huge engineering challenges, as well as a huge cost. A water diversion project currently under way in Yunnan Province, which includes a 600 km tunnel, is seen as a demonstration project "to show we have the brains, muscle and tools to build super-long tunnels in hazardous terrain—and the cost doesn't break the bank", said Zhang Chuanqing at the Chinese Academy of Sciences' Institute of Rock and Soil Mechanics.

A plan for the Tibet-Xinjiang tunnel project was submitted to the central government in March 2017. A team of over 100 scientists did the planning.

Videos of the central route can be seen at: https://www.youtube.com/watch?v=7s5UungzXhw and https://www.youtube.com/watch?v=oBhAqvbcpqE&t=16s

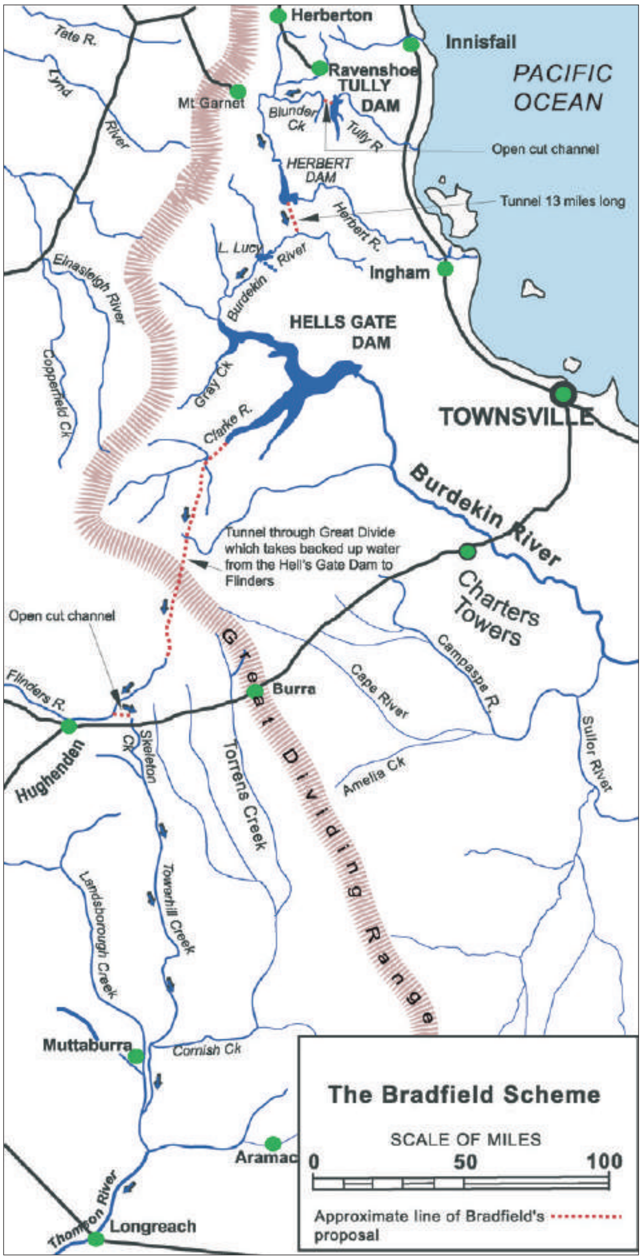
The Shunping section of China's South-North Water Diversion Project. Photo: china.org.cn

The Bradfield Scheme

Australia once had an infrastructure vision like China is applying today, for moving water from areas of plentiful rainfall to where it is needed for agriculture, with the Snowy Mountains Scheme the best example. However, the political will has been lost. Given China's focus on infrastructure with the Belt and Road Initiative, now is the perfect time to revive other such proposals like the Bradfield Scheme, described below, which has been gathering dust on the shelf for 80 years.

At the direction of the Queensland state government, in 1984 four of Australia's bestknown hydraulic engineering firms combined to form the Bradfield Study Consortium. Their Bradfield Study Consortium Report, together with an optimistic assessment by the Department of Northern Development, was never officially released due to a change of government in Queensland. But in July 1993, all of the relevant Shire Councils of North and Central Queensland joined together to form the Northern Australian Water Development Council, to fight to make engineer John Bradfield's dream a reality. The estimated cost of the revised Bradfield Scheme (which called for pumping water over the Great Dividing Range instead of the tunnel originally foreseen by Bradfield, among other changes), was at that time $2.49 billion. The state of Queensland's Office of Northern Development projected that the scheme would create $2.02 billion *annually* in direct output from the cattle industry, agriculture, etc., not to mention the billions saved in drought losses. Vast numbers of jobs would be created, both in the construction and in the follow-on development of this area.

Since the time Bradfield proposed his scheme, the Burdekin Falls Dam on the Burdekin River was completed in 1987, in the middle catchment of the Burdekin, with a storage of around 1.85 million megalitres. Whether or not the Burdekin is utilised in the revised Bradfield Scheme, Stage 2 of the development of that dam should go ahead, under which the dam wall would be raised (it was built to allow for such expansion), which would allow the storage to increase to 8.5 million megalitres above its current capacity.



During World War II and for some years later, the Bradfield Scheme was regarded as the logical next step in building and securing our nation, after the Snowy. Beginning in the early1980s, Queensland MP Bob Katter revived the scheme, in a revised form.