Tibetan power: A unique hydro-electric macroproject servicing India and China

Richard Brook Cathcart

Joint India–China development and utilization of waterpower resources in eastern Tibet could facilitate a mutually beneficial balance of geopolitical power in the Himalaya. A multi-national macroproject, consisting of one inflatable bladder dam, a short pressure tunnel and a powerhouse, all harnessing the sharp descent of the Yarlung Zangbo (Brahmaputra River) at a topographic course loop, could supply Earth's two most populous nation-ecosystems a low-cost means of rapidly improving national standards of living.

Modern-day geopolitical competition between India and China over parts of Tibet indisputably started on 20 October 1962; since that deadly military confrontation, both nation-ecosystems have mainly indulged in a lively diplomatic jousting match. A speculative 25 May 1999 letter to the Editor of *Current Science*, 'Why does river Brahmaputra remain untamed?'[1], offered a very expensive, and technically complex, macroproject answer – involving canals, aqueducts, drainage channels, tunnels, river-training embankments – most probably because K. S. Valdiya decided against any public discussion of a simpler, widely-known, and cheaper internationalized macro-engineered project.

China established a Tibet Autonomous Region (TAR) in 1965; the TAR's 1990 population was ~ 2.2 million persons, native Tibetans then accounting for 80–90% of that estimate. In the TAR region east of Lhasa closest to India, the main river is the Yarlung Zangbo, which has a drainage basin of ~ 328,300 km^2 and an average annual freshwater discharge of ~ 4,160 m^3/s. This river may have a hydropower potential of 296.8 TWh in Tibet. Since 90% of China's coal deposits are located north of the Yangtze River, which will be tamed by the Three Gorges Dam early in the 21st century, it may be necessary to harness Tibet's abundant surface water resources. A pumped-storage facility incorporating a tunnel has been built at Yangzhuyong Lake – located 9.5 km south of the Yarlung Zangbo and 90 km from Lhasa – which, since 1997, furnishes Lhasa with its first reliable electricity supply; it seems likely TAR's ongoing industrialization will further increase the region's base and peak electricity loads. And, China is a major 'player' in controlling greenhouse gas emission globally[2].

World's no. 1 hydropower site?

The 1,790 km long Yarlung Zangbo exits the Qinghai–Tibet Plateau near the 7,756 m high Namjagbarwa Feng, passing from Miling County at the entrance to a steeply sloping canyon, thence to the town of Wulang in Medog County, TAR. A 42 km long bored pressure tunnel, with a fall of ~ 2,160 m, could carry the river's flow through staged Francis turbines, annually generating ~ 240 TWh; this unique installation would very likely be our land-based civilization's mightiest renewable electric power-producing facility. An India–China cooperative TAR macroproject would obviate any need for China alone to pursue an old-fashion-style (post 20 October 1964) macro-engineering plan involving peaceful nuclear explosions bruited during the December 1995 Beijing meeting of the Chinese Academy of Engineering Physics, to excavate a 20 km long canal through an intervening mountain range north of the Yarlung Zangbo in order to convey irrigation-quality water to the Gobi Desert[3].

India's astute macro-engineers have relevant practical experience with Himalayan tunneling. Considering what has already been accomplished in Switzerland's riddled Alps, as well as the record-setting burrowing achievements of the Finns in supplying freshwater to their capital[4], this proposed macroproject is doable at a reasonable monetary cost, even without anticipating tunneling technology's progress.

Macro-project particulars

When this TAR-sited macroproject is discussed, too often it is envisioned as a gigantic concrete or concrete-faced rock-fill dam-pressure tunnel combination. China has gained construction experience with large concrete gravity dams on rivers in the most populated provinces of its vast national territory-ecosystem. A rock-fill dam on the Yarlung Zangbo upstream from Namjagbarwa Feng will naturally have to be at a discovered site of excellent foundation rock, with cement grouting treatment as required, and a reasonably high compressive modulus rock-fill. An additional difficulty is the possibility of reservoir-induced earthquakes in a seismically-active TAR mega-graben; , massive rock slides can be stimulated by heightened groundwater levels behind dams, as well as by distant strong earth tremors. China, India or stream-sharing Bangladesh citizens must never have to endure a catastrophic dam over-topping such as tragically occurred at Italy's Vaiont Dam on 9 October 1963; a 19 June 1999 *New Scientist* (**162**, #2191, p. 4) news-flash written by Fred Pearce (Hell and high water) revealed the awful prospect of a similar catastrophic mega-flooding disaster afflicting Amudar'ya River valley-dwelling peoples located downstream of Tajikistan's Sarez Lake when a dangerously unconsolidated natural rock-fill barrier formed by a 1911 earthquake-induced landslide suddenly crumbles. The Amudar'ya River terminates at the disastrously evaporating Aral Sea.

But, what if India–China macro-engineers opt to build a simple low-rise inflatable dam at the key site (near lat. 29°50'N, long. 95°10'E) on the Yarlung Zangbo in the TAR?

Generalities of persuasion

Instead of installing a large, high anc costly concrete or rock-fill gravity dam, ε < 10 m tall nylon-reinforced rubbe bladder (when utilized, filled by either ai or water) securely anchored in a rock-locked steel-reinforced concrete base-plate will induce a shallow freshwater reservoir to quickly accumulate[5–8]. Subsequently, ~ 100% of the river's flow can be diverted (during appropriate times or season) directly to the pressure tunnel's head-gate. Nearly abandoned, the steep deep-canyon stream's bed may then be transformed into a topographically descending series of stepped runoff and erosion control sediment-trapping basins; its appearance then will resemble the 12 June–25 November 1969 dewatering of the Niagara River's American Falls Channel – a period which encompassed the First Moon Landing – and its future anthropogeomorphological state may be as identically iffy as that which Shailer S. Philbrick (1908–1994) projected for an unrestored Niagara Falls landscape region[9]. Water flow fluctuation means the pressure tunnel must be very well designed, dug and defended by a strong impermeable lining. An impoundment with a shallow pool depth ought not increase significantly the local seismicity and rock-slide hazard.

Imagine an integrated hydropower-generation and super-conducting electric power delivery grid netted throughout the Himalayas, serving the geopolitical and economic development interests of India, China and other inter-linked national ecosystems! The more vociferous Greens beg or bully India and China not to burn their affordable existing coal resources – to delay the onset, or to reduce the final overall impact of, a commonly alleged 'enhanced global atmospheric warming' – the more self-righteous India and China may become when they do jointly harvest the TAR's hydropower for further separate industrialization; India and China are space-faring UNO members which remain bedeviled by down-to-earth widespread low human standard of living levels. Cooperation of these two major players as guides for Tibet's future economic development may ensure their own 21st century peace and prosperity!

Tibetans ought to have an important role in this proposed flood-mitigation and developmental macroproject's planning as well as its post-construction operation, especially if they can tolerate a small alteration in their sacred river's altitude (i.e. its flowing level) or its temporary capture for industry's use. In Tibet the major environmental impact should occur in the low-flow river within the valley north, east and south of Namjagbarwa Feng. However, the inflatable dam can be deflated, or removed forever, at any time! This macroproject might be undertaken during 2002, which was declared (on 10 November 1998) by the United Nations Organization to be the 'International Year of the Mountains'[10].

1. Valdiya, K. S., *Curr. Sci.*, 1999, **76**, 1301–1305.
2. Michaelson, J., *Stanford Environ. Law J.*, 1998, **17**, 73–140.
3. Horgon, J., *Sci. Am.*, 1996, **274**, 14–15.
4. Niini, H., *Eng. Geol.*, 1967, **2**, 39–45.
5. Tam, P. W. M., *ASCE J. Irrig. Drainage Eng.*, 1997, **123**, 73–78.
6. Chanson, H., *ASCE J. Irrig. Drainage Eng.*, 1998, **124**, 181–184.
7. Plaut, R. H., *Civil Eng.*, 1998, **68**, 62–64.
8. Anon, *ENR: Eng. News-Rec.*, 1999, **242**, 20.
9. Philbrick, S. S., *Geol. Soc. Am. Bull.*, 1974, **85**, 91–98.
10. Ives, J. D., *Arctic Antarctic Alpine Res.*, 1999, **31**, 211–213.

Richard Brook Cathcart is at GEOGRAPHOS, 1608 East Broadway, Suite #107, Glendale, California 91205-1524, USA.

SCIENTIFIC CORRESPONDENCE

Temperature-dependent cell transformation in a calcium-binding protein from *Entamoeba histolytica*

Temperature is a principle state variable which governs the structural, physical and functional properties of proteins to a large extent. We have observed an unusual temperature-dependent structural transition while attempting to collect X-ray diffraction data at room temperature (20°C) and at 4°C. This temperature-dependent cell transformation was observed in a calcium-binding protein (CaBP) from *Entamoeba histolytica*[1,2]. This CaBP is very similar to the structurally well-studied archetypal calmodulins (CAMs)[3] with two calcium-binding domains separated by a central linker. It is, however, smaller than CAM (134 residues) and has a two-residue insertion in the linker region. As a control, similar studies have also been carried out on small proteins like ribonuclease and lysozyme. These studies suggest that this kind of cell transformation is not a general phenomenon.

Crystals of native CaBP were obtained in 63% MPD, 10 mM $CaCl_2$ and 100 mM sodium cacodylate buffer (pH 4.3) using protein at a concentration of 10 mg/ml (ref. 2). Typical crystal dimensions were 0.6 × 0.2 × 0.2 mM. The crystals belonged to the space group $P6_122$. Diffraction data collection was carried out using a CuKα X-ray source provided by a Rigaku RU200 rotating-anode generator equipped with a 0.2 mM focusing cup and operating at 40 kV, 56 mA. Data were collected on a MAR Research imaging plate system at a crystal to film distance of 150 mm. The oscillation angle was set to 1°. Constant temperature was maintained using an Oxford Cryosystem Cryocooler. Each frame was exposed for 15 min and a total of five frames were collected at each temperature. The data set was processed using the DENZO/SCALEPACK suite of programs and the cell parameters were determined for each temperature.

The cell parameters determined for each of the eight different temperatures are shown in Table 1. As can be seen, the volume of the unit cell shows a