

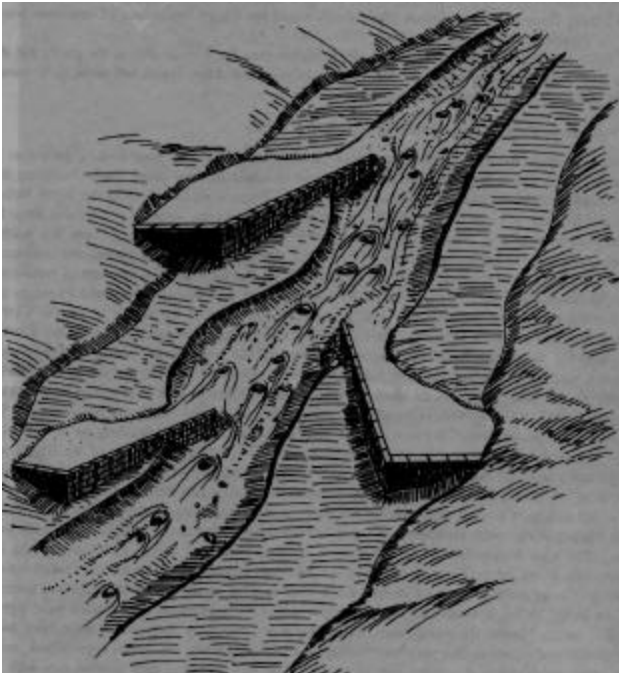
# Water management: Historical maritime, riverine tradition of Bharat

## Introduction

The history of science and technology in Bharat is replete with examples of the use of scientific water management techniques and the setting up water grid to support a regulated irrigation system and flood control mechanisms. Aapah, sacred waters have united the nation for millennia and Manasarovar, Mount Kailas has always been the cultural capital of Bharat.

With this Bharatiya tradition, we can confidently move forward with the programme for creating a National Water Grid and use of water harvesting and conservation procedures to ensure optimum utilization of the country's water resource and to ensure the equitable distribution of the resource to all parts of the country and as a corollary, mitigate the recurrent phenomena of twin problems of flooding in some parts and of drought situations in other parts. Such a national perspective in managing the water resource will help achieve the target of doubling of agricultural production in the next 5 years to cope with the anticipated growth in population. The National Water Grid project by itself has the potential of taking Bharat into a developed country status by the year 2010.

## Irrigation in the Sarasvati Civilization period



### A profile of a Gabarband, on river Hab.

At Mehrgarh Period II (Burj Basket Market period): "The charred seeds of wheat and barley belonging to the species *triticum sphaerococcum* and *hordeum phaerococcum* that, according to L. Costantini, grow only on irrigated fields, also were collected from the ashy layers" of P:eriod II (Jarrige, Jarrige, Meadow and Quivron, 1995, *Mehrgarh: Field Reports 1974-1985, from Neolithic times to the Indus Civilization*, Karachi, Department of Culture and Tourism of Sindh, Pakistan, Department of Archaeology and Museums, French Ministry of Foreign

Affairs, pp. 318-19)"

An irrigation system used involved bunding including the construction of a low earthen or stone wall, known as kach or gabarband. There are many gabarbands in Sindh

Kohistan, Kirthar area and Baluchistan (Gedrosia). Gabarband means a 'Zoroastrian dam' because gabars are Zoroastrians or fire-worshippers. Gabarbands, as shown in the figure, are L-shaped, were used to slow down the flow of water in a stream, and to direct the flood waters and to allow the build up of alluvium behind the structures. Louis Flam (1981, *The Palaeogeography and prehistoric settlement patterns in Sind, Pakistan*, (4000-2000 BC), PhD Dissertation, University of Pennsylvania) notes that the gabarband began in the Amri-Nal phase in the first half of 3rd millennium BCE. The gabarbands ensured the conservation of soil and created an agricultural field with alluvial soil.

The kallanai or Grand Anicut on River Kaveri is patterned like a gabarband.

Chola king of 11<sup>th</sup> century, who brought sacred Ganga waters to the temple tank, Cholaganga at Gangaikonda Cholapuram

Rajendra Chola (1014-1044). He was victorious upto the banks of River Ganga. Gangaikonda Cholapuram is the name of the place, 61 kms. from Tiruchirapalli, where he built a temple for Brihadees'vara to commemorate his victories. Gangaikonda Cholapuram means, 'the city of the Chola who took the Ganga'.

After his victorious campaign, he did not ask for tribute of land or gold or riches; he asked for



Gangaikonda Cholapuram Temple

and brought back, water from the river 'Ganga' in a golden pot, and sanctified the reservoir or the temple tank called 'Ponneri or Cholaganga'. Thus he was given the title of 'Gangaikondan'(the one who brought the Ganga).

**Gangaikonda Cholapuram. Brihadees'vara temple (11<sup>th</sup> century)**



A frieze in the temple depicts King Rajendra being crowned by Somaskanda S'iva accompanied by Parvati. The serpent adorning the neck of S'iva becomes the crown.

**Chola king who built 2000 years ago, the world's earliest water-regulator structure in stone at Kallanai (Grand Anicut)**

North of Gangaikonda Cholapuram is the Grand Anicut (or Kallanai) – 24 kms. from Tiruchirapalli -- built of stone in the second century AD by King Karikaala Chola.



**L-shaped Kallanai or Grand Anicut on River Kaveri**

This is the oldest stone water-diversion or water-regulator structure in the world. The L-shaped structure, 329 m. long and 60 m. wide was intended to regulate the flow of Kaveri river waters to the northern parts of Tamilnadu, towards Kolladam, to bring more land of the Kaveri delta under irrigation channels. The L-shaped structure is comparable to the 'gabar bands' (dated to circa 5000 years before present) which were used to fork out the water flows on the River Sindhu to provide for regulated water supply to the settlements; the 'gabar bands' perhaps constitute the earliest water-regulator systems in the world. At an archaeological settlement of Kalibangan on the banks of River Sarasvati (tributary, Drishadvati), a ploughed-field was also discovered attesting to the early agricultural systems of the civilization, using the waters drawn from the River Sarasvati. It is notable that Rishi Gritsamada talks eloquently about Sarasvati as ambitame, naditame, devitame Sarasvati, i.e. best of mothers, best of rivers and best of divinities. She was indeed a mother because she nurtured a civilization on her river banks and gave raise to new technologies related to material phenomena harnessed with due regard to the ecological system.

The water-regulator has stood the test of time. This 2,000 year old water-regulator stands firm even today and is considered an engineering marvel. Similar water management structures have been found in Southern Africa and it is surmised that these were built by the descendants of the people who constructed the Kallanai. The stone structure is still in use and a road bridge has been built on top where visitors can drive through or walk along. Another dam called the Upper Anicut, which is 685 m long, was constructed across the river Kollidam (Coleroon), the branch of River Kaveri, in the 19th century.

Kallanai was built to harness the waters of River Kaveri in times of drought. Before this dam was built, the waters were flowing directly into the sea. The ancient engineers of Bharat have created irrigation system with innumerable interconnected small resevoirs



with networks of irrigation channels. This system assured supply of water even in the summer season and avoided devastations caused when the rivers were in spate.

## Legacy of water-management of Sarasvati Civilization (circa 5300 years before present)

### Inner layout of the North Gate, Dholavira

[http://asi.nic.in/album\\_dholavira2.html](http://asi.nic.in/album_dholavira2.html)



(Archaeological Survey of India website)

Dholavira is an archaeological site of the civilization in the Rann of Kutch (Gujarat). This site revealed the most remarkable water management systems, which are perhaps the earliest systems of their kind in the world, dated to about 5300 years before present.

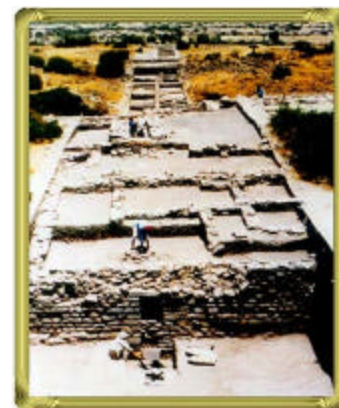


**Dholavira. Huge reservoir.**



**Dholavira. Covered storm-water drain.**

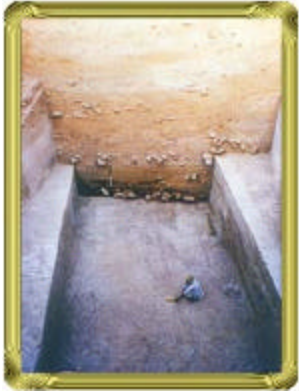
**Dholavira. Broadway and the drain outlet.**



The following pictures depict the top-view and the inside of a stone-lined water drain to carry water into the s.

A remarkable find at Dholavira excavation was a unique water-harnessing system, together with a storm-water drain. A 7-metre deep rock-cut reservoir with a confirmed length of 79 metres was a significant discovery. This is an awesome structure because it has been cut through rock, together with a storage tank and 50 stone-steps. Another, equally deep reservoir of fine stone masonry was also found.

The reservoirs skirted around the metropolis which was fortified with stone-walls while the citadel and baths were centrally located on raised ground.



Dholavira. Rock-cut reservoirs.



**COURTESY ARCHAEOLOGICAL SURVEY OF INDIA**

Giant reservoirs at Dholavira (the largest measuring 263 feet by 39 feet and 24 feet in depth) that together held more than 325,000 cubic yards of water.

<http://www.archaeology.org/0011/newsbriefs/aqua.html>

[http://asi.nic.in/album\\_dholavira9.html](http://asi.nic.in/album_dholavira9.html)





**Dholavira. Well and other water structures.**

[http://asi.nic.in/album\\_dholavira4.html](http://asi.nic.in/album_dholavira4.html)

A large well was discovered, equipped with a stone-cut trough to connect the drain meant for conducting water to a storage tank. Circular structures found at the site, conjoining like the figure eight are surmised



to be used for bathing. Most notable is a bathing tank with steps descending inwards. Water from the nearby streams were harnessed and gathered into a reservoir and further moved to charge the dug wells which supplied water to parts of the metropolis.

**Dholavira. Bathing tank.**

These structures for effective water conservation and irrigation management are exemplified by the pushkarini in Mohenjodaro. The pushkarini is not unlike the Chola Ganga tank in front of the Brihadis'vara temple in Gangaikonda Cholapuram and many such pushkarinis in front of many temple all over Bharat.



**Mohenjodaro Pushkarini with steps**

The floor of the tank is water tight due to finely fitted bricks laid on edge with gypsum plaster and the side walls were constructed in a similar manner. To make the tank even more water tight, a thick layer of bitumen (natural tar) was laid along the sides of the tank

and presumably also beneath the floor. Brick colonnades were discovered on the eastern, northern and southern edges. The preserved columns have stepped edges that may have held wooden screens or window frames. Two large doors lead into the complex from the south and other access was from the north and east. A series of rooms are located along the eastern edge of the building and in one room is a well that may have supplied some of the water needed to fill the tank.

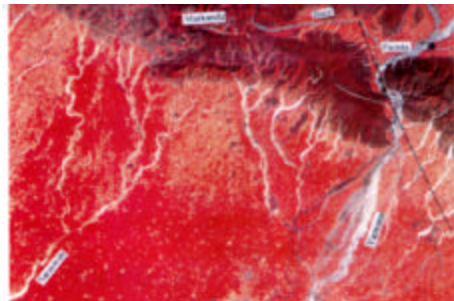


A brick-lined drain. Mohenjodaro

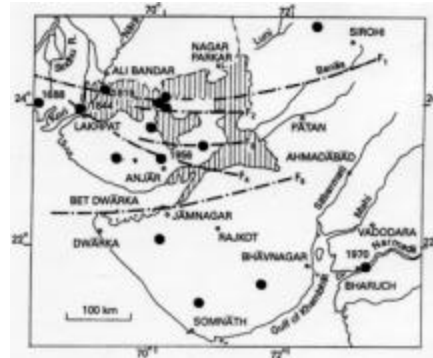
**A note on the history of River Sarasvati and lessons for the future National Water Grid**

Siwalik hills were left-laterally displaced. NNW-SSE-trending tear fault is still active. The earlier west-flowing rivers were swung southwards, following the path of the fault. The Bata stream which joins Yamuna from the west has a very wide valley. [NRSA, ISRO, Hyderabad]

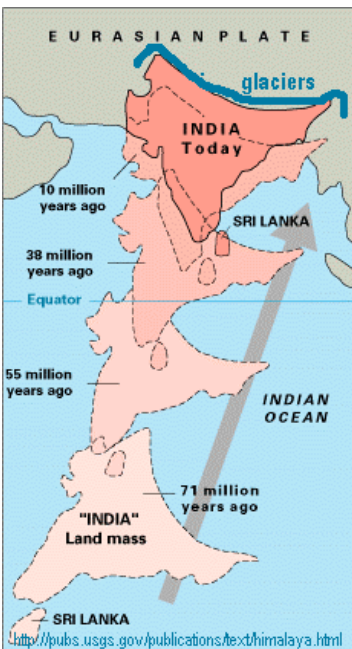
**Earthquakes in Kutch and Saura\_s.t.ra, with EW trending faults. Bet Dwaraka and Dholavira are close to these faults. [After Biswas, 1987; Rajendran and Rajendran, 2000].**



**The Indian Plate is still active tectonically and is moving at the rate of 7 cms. per year resulting**

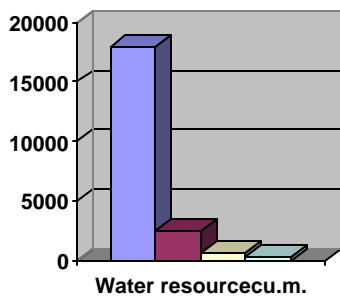


**in the continuing rise of the Himalayas at the rate of 1 cm. per year.**



6000km. Journey of Bha\_rata in 40-50 m. years It is no coincidence that the majority of the Earth's glaciers are found in the American Cordillera (Andean, Rockies, and Alaska/BC), Alps, and Himalaya. Each of these are areas of geologically recent (less than 100 million years) mountain building associated with **Plate Tectonics**. Mountains cause disturbances in airflow, altering global circulation patterns. The plate tectonics result in migrations of Himalayan river courses as evidenced by the migratons of Kosi and Brahmaputra rivers. The patterns of glacier recharge also may result in variations in the quantities of water which flow through the tributaries of River Ganga making it essential to establish arrangements for inter-basin

water transfers of the type contemplated by National Water Development Agency to ensure continued support to command area of irrigation in the Ganga basin. This will also help cope with the variations in water runoffs in the river basins of the country.



Variations in Space: An equity issue. 65% used for agriculture; 8% for drinking.

Assam has the highest rainfall; about 1,143 cm. (450 in.)(highest recorded in the world) while the desert areas of Rajasthan get less than 1207 mm. (5 in.) of rainfall.

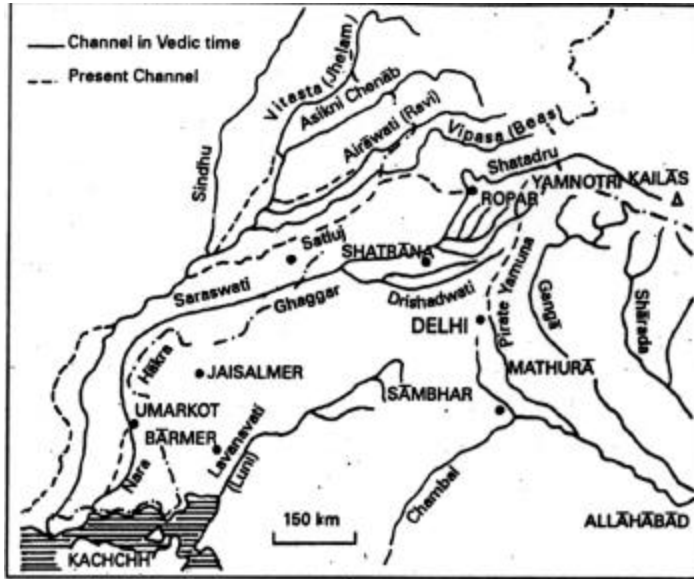
Brahmaputra and Barak rivers account for 32 per cent of the country's water resources; Ganga river accounts for 28 per cent. Both Brahmaputra and Ganga River Basins are prone to the recurring feature of floods.

In Brahmaputra the availability of water is estimated to be 18,000 cubic metres (cu.m.); in Mahanadi, the estimate is 2500 cu.m. and in Kaveri river basin and Palar-Pennar river basin, it is as low as 650 cu.m. and 380 cu.m. respectively.



Plate X [c] Lingam in situ in Trench Ai (MS Vats, 1940, *Excavations at Harappa*, Vol. II, Calcutta): 'In the adjoining Trench Ai, 5 ft. 6 in. below the surface, was found a stone lingam [Since then I have found two stone lingams of a larger size from Trenches III and IV in this mound. Both of them are smoothed all over]. It measures 11 in. high and 7 3/8 in. diameter at the base and is rough all over.' (Vol. I, pp. 51-52)S'iva linga is shaped after the summit of Mt. Kailas on the foothills of which is the Manasarovar Glacier lake which is the cultural capital of Bharat.





For millennia, people from all parts of Bharat have performed tirthayatras to these sacred waters. The Manasarovar glacier the source of 5 mighty rivers: Sindhu, Sutlej, Sarasvati, Mahakali-Karnali-Sharada and Tsangpo-Lohitya-Brahmaputra. Fiver other rivers emanate from the eastern Himalayas: Irawaddy, Salween, Mekong, Yangtse and Huanghe. These glacial rivers nourish 250 crores of people in Bharat, China, Burma, Laos, Cambodia and Vietnam.

Vedic Sarasvati is not myth; but bhu\_mi satyam, ground-truth, 1600 km. long river, 6 to 8 kms. wide channels, from Manasarovar to Prabhas Patan (Somnath). Tamasa (with Yamuna) and Sutlej rivers, and Dr.s.advati (now represented by Chautang) were tributaries of River Sarasvati. [After KS Valdiya, 1996].

Himalayas are thus the Great Water Tower nourishing great civilizations of Asia for millennia and will continue to nourish the civilizations for many more millennia. Great Water Tower for 250 crore people

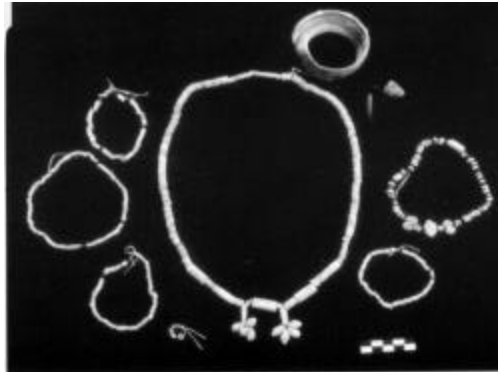


Himalaya is the source of major rivers for 2.5 billion people; Manasarovar in Tibet yields Sindhu, Sutlej, Sarasvati, Mahakali-Karnali-Sharada and Tsangpo-Lohitya-Brahmaputra rivers; other rivers flowing from eastern Himalaya are: Irawaddy, Salween, Mekong,

Yangtse and Huanghe. Precipitation levels increase along the Himalaya from Karakorm (250 cm. per annum) to Cherrapunjee, Assam (1410 cm p.a.) registering the highest rainfall regions of the world. Since 1959, Chinese government estimates that they have removed over \$54 billion worth of timber.

**TURBINELLA PYRUM, S'AN:KHA KR.S'ANA conch-pearl bangle**

Burial ornaments made of shell and stone disc beads, and *turbinella pyrum* (sacred conch, s'an:kha) bangle, Tomb MR3T.21, Mehrgarh, Period 1A, ca. 6500 BCE.



The nearest source for this shell is Makran coast near Karachi, 500 km. South. [After Fig. 2.10 in Kenoyer, 1998].

Parvati, wore conch shell bangles – s'an:khaka -- created by Sage Agastya Muni and Divine architect Vis'vakarma. S'an:kha is a Kubera's treasure – one of the nine or nava-nidhi-s.

The bronze statue of a woman wearing bangles and holding a small bowl in her right hand, Mohenjo-daro (DK 12728; Mackay 1938: 274, pl. LXXIII, 911); was made using *cire perdue* (lost wax) method, a method used by vis'vakarma-s in Swa\_mimalai to make bronze figurines of deities – vis'vakarma tradition lives on.



**Kanjari** : a long blouse embroidered and with mirror work. Shell bangles are worn by a Kutchi woman, from wrist to shoulder – a cultural heritage from the Sarasvati-Sindhu civilization as evidenced by the bronze statue found at Mohenjodaro wearing bangles in similar style.



**USES OF TURBINELLA PYRUM (s'an:kha, conch-shell) for libation, trumpet, seal** Mohenjodaro: libation vessel made from *turbinella pyrum*. Spiralling lines were incised and

filled with red pigment. The vessel is used to anoint kings and to dispense sacred water or milk. Used even today for ritual oblations and to dispense medicinal preparations.[After Fig. 6.38 in Kenoyer, 1998; J. M. Kenoyer, 1983, Shell working industries of the Indus Civilization: an archaeological and ethnographic perspective, PhD diss., UCAL, Berkeley]. 11.4 X 5.4

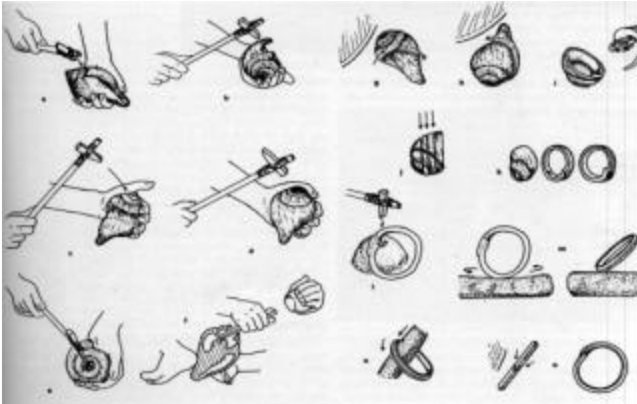
cmAt Bet Dwaraka...A small rectangular seal (20 x 18 mm) of conch shell with a perforated button at the back was found in trench UW6 of Bet Dwarka. A composite animal motif representing the short horned bull, unicorn and goat are engraved in an anticlockwise direction.



*Turbinella  
pyrum*  
conch  
shell  
trumpet.  
Hole at  
apex is  
roughly  
chipped.  
Used to  
call people

for battle or ritually throughout South and Southeast Asia. Essential component of Hindu and Buddhist traditions, one of 8 auspicious symbols. 9.66 X 5.1 cm. Harappa; Lahore Museum, P501 A. An As skilled sawyer and shells ready for sawing, Calcutta.

*Turbinella pyrum* shell bangle manufacturing process. [a to f]: preliminary chipping and removal of internal columella; [g to k]: sawing shell circlets; [l to n]: finishing the shell blank; [o]: final incising [After Fig. 5.23 in Kenoyer, 1998]



**KR.S'A\_NU = A BOWMAN?  
Shell-cutter with a bow saw**

With those aids by which you defended Kr.s'a\_nu in battle, with which you succoured the horse of the young Purukutsa in speed, and by which you deliver the pleasant honey

to the bees; with them, As'vins, come willingly hither. [Kr.s'a\_nu are somapa\_las, vendors or providers of Soma; hasta-suhasta-kr.s'a\_navah, te vah somakrayan.ah (*Taittiri\_ya Sam.hita\_1.2.7*); kr.s'a\_nu = agni; purukutsa was the son of Mandha\_ta\_ and husband of Narmada\_, the river; the text has only 'of the young', Purukutsa is added] (RV 1.112.21). S'AN:KHAH KR.S'ANAH = PEARL SHELL WON FROM THE OCEAN AND WORN AS AN AMULET (AV 4.10.1)

Rigveda: 1.112.21

yai->! k~~z~~an~~m~~! Ashe Êvšywaè j x/e yai-ŕœybaè AvRt~~m~~! Aav?tm!  
mxliàym! -ŕwaèyt! sŕfoys! tai-ŕœ /; u^iti-ŕœAĩ~~n~~na g?tm! .



Sandstone sculpture of S'iva Bhairava, holding a conch in his left hand, 11th cent. S'ivapuram, South Arcot Dist., Bha\_rata (Dept. of Archaeology and Ancient History, MS Univ.,



Vadodara).VIS.N.U BLOWING S'AN:KHA TRUMPET

"**valampuri por-itta ma\_ ta\_n:ku tat.akk kai**" (mullaippa\_t.t.u: 2) "the long arms with finger prints of valampuri [conch with clockwise turns] and embracing Tirumakal. (or Laks.mi)" The terracotta plaque is at the Brooklyn Museum, U.S.A. On stylistic grounds it can be ascribed to the fifth century and also be presumed to have originally belonged to the brick temple of Bhitargaon, Kanpur District, Uttar Pradesh. The plaque has been described by Dr. Army Poster (*Figures in Clays from Ancient India*, No. 52, Brooklyn, 1973) and by Dr. Pratapaditya Pal (*The Ideal Image: The Gupta Sculptural Tradition and Its Influence*, Fig. 28, p.81, the Asiatic Society, Inc. 1978).

**Vishnu's fight with the Rakshasas led by Malyava\_n, Ma\_li and Suma\_li as narrated in the Uttarka\_n.d.a of the Ra\_ma\_yan.a (Cantoes VI-VIII).** [A Terracotta Panel from Bhitargaon Showing a Ramayana Scene By P. Banerjee <http://ignca.nic.in/pb0020.htm>]

### **Water-based coastal s'ankha industry and a riverine civilization**

Rishi Gritsamada in Rigveda adores River Sarasvati in ecstatic terms as: ambitame, naditame, devitame Sarasvati (best of mothers, best of river and best of divinities).

This is emphatic evidence that even in the days of the Rigveda (ca. 5000 to 7000 years Before Present), River Sarasvati had attained the status of a divinity and was venerated as an apri devata in the yajnas. She was adored because she nurtured a civilization on her banks and saw the emergence of new arts and crafts, a bronze-age civilization and a writing system to transport artefacts made by artisans across large distances in a maritime, riverine cultural setting. This is exemplified by the Amri-Nal phase of the civilization along the coastline of Gulf of Khambat, Gulf of Kutch and Makran Coast. The s'ankha (*turbinella pyrum*) industry which was in vogue in 6500 BCE continues even today in Kizhakkurai, Tiruchendur in Gulf of Mannar. A valampuri s'ankha is priced at Rs. 25,000 and there is an office of the West Bengal Development Corporation which buys the s'ankha picked up from the shallow coasts; an average s'ankha is priced at Rs. 10 and the s'anha kris'aana works on the s'ankha to produce bangles, conch-trumpets and oblation vessels. The s'ankha adorns the hands of Narayana and Bhairava symbolising the treasures of the waters as do the images of samudra manthanam painted on a cave in Ellora and on a frieze in Ankor Wat temple in Cambodia.

Samudra or ks.i\_rasa\_gara manthanam, 'Churning of Ocean of Milk' Deva and Da\_nava churn the ocean, using Va\_suki, the serpent as the rope and Mandara, the mountain as the churning rod. Ganesh Lena, Ellora, ca. 11th cent. AD.



Bas relief of the 12th-century temple of Angkor Wat, Cambodia.  
Stone step-wells of Bharat

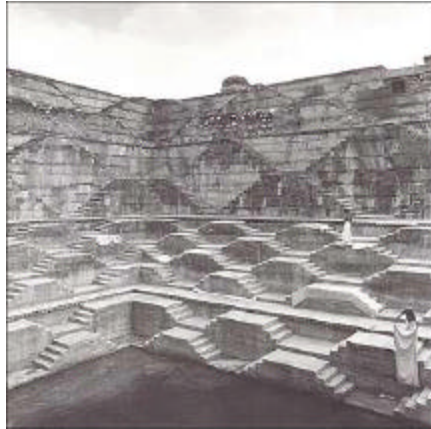
An outstanding achievement of Bharatiya civilization is the architecture in stone adorned with stone sculptures and rock-cut viha\_ra-s and many forts built in stone. Breath-taking are the stepped wells of Gujarat and Rajasthan many of which are over 1,000 years' old. Over 120 such wells are founding Gujarat. These are called *bawari* or *baoli* in Rajasthan. [cf. *ba\_vi* stepped well (Telugu)] "From the 5th to the 19th centuries, the people of western India built stone cisterns to collect the water of the monsoon rains and keep it accessible for the remaining dry months of the year. These magnificent structures - known as stepwells or stepped ponds - are much more than utilitarian reservoirs. Their lattice-like walls, carved columns, decorated towers and intricate sculpture make them exceptional architecture, while their very presence tells much about the region's ecology and history."





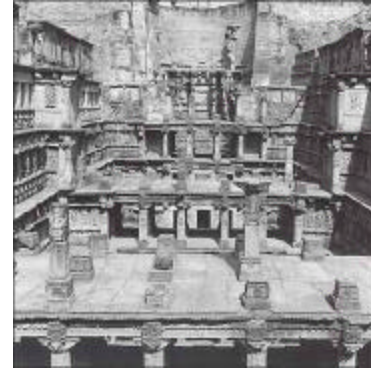


**Panna Mia stepped-pond.** [After Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*]



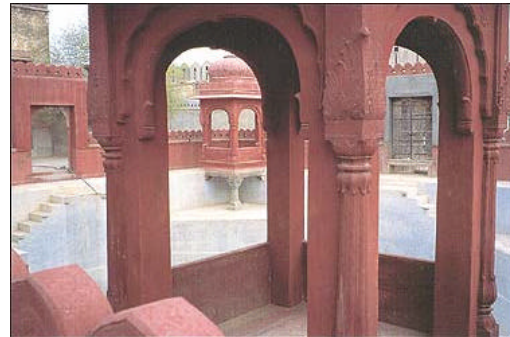
**Vasant Garh stepped-pond, Rajasthan** [After Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*]

**Hadi Rani Well, Toda Raisingh, Rajasthan** [After Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*]



**Rani-ki-vav, Patan, Gujarat** [After Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*]

**Nimrana stepwell, Rajasthan** [After Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*]



**Stepped well in S'iva vadi temple, Bikaner** [After Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*]



**Cistern, Nahgarh fort, Jaipur** [After Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*]

The architectural excellence finds an early, utilitarian expression in the rock-cut reservoirs of Dholavira and the tradition continues in the building of step-walls in many parts of the country. “Water. It is revered whenever it's hard to find, in places where the dry and draining heat burns for months on end, where monsoon rains visit only in summer, then vanish. To cope with this parched life, the people of western India more than a 1000 years ago built wells. But not the holes in the ground we know as wells, these were ornate, magnificent, maze-like structures made of stone, some 90 feet deep. Stepwells; respite from the heat and hallowed receptacle for that essential water. A place to bathe, to



drink, and to pray.” [cf. Morna Livingstone, Milo Beach, 2002, *Steps to Water; The Ancient Stepwells of India.*”]

The historical tradition of social dharma in Bharat, connoted by *samudra manthanam*, the dharma of cooperative enterprise will help organize for optimum utilization of water resources in the country for many years to come.

