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Puthuvypin-Vallarpadam Port Project: Is there a Future?

Commander John Jacob Puthur (Retd)*

A special economic zone (SEZ) was established within the Kochi Port limits to build the Puthuvypin-Vallarpadam Port. Puthuvypin, in Malayalam language, means 'new Vypin'. In the present case Puthuvypin is a new part of the Vypin Island. In geological terms, it is a very recent creation, formed by a process of deposition of sediments – sand, silt and clay – that began about three decades ago. Puthuvypin has since grown seaward by more than 1,000 acres. The Kochi Lighthouse, which once was along the shoreline, is now way inland. This has thrown open a host of unanswered issues: what are the factors that led to this rapid growth of the Vypin shoreline? Where did the sediments come from? How did it get there? Will this growth continue in the future and what will be its impact? Is there a chance that this growth will stop, or even be reversed, in the foreseeable future? If so, what will be the impact on the port's viability? The present paper aims to answer these questions. It also seeks to address the objectives of the authorities in developing the Puthuvypin-Vallarpadam Port. The moot question remains: whether the authorities have investigated the above-mentioned issues, and diligently searched for the answers, or did they proceed with the project only because the land was 'free', a no-man's land, which could be exploited without evicting anyone or compensating anyone?

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Puthuvypin

Much of the Puthuvypin port is slated to house massive storage tanks, a tank-farm for petroleum products, both crude and refined, meant for the Kochi Refinery. It means that thousands of tonnes of petroleum products will be stored on this geologically fragile landscape. The plan is to set up a “single buoy mooring” offshore, to receive very large crude carriers (VLCCs). The crude will then be pumped into these tanks for onward transfer to the refinery. The construction of the tanks is progressing rapidly.

Apart from the storage tanks, the authorities are also planning a liquefied natural gas (LNG) terminal and re-gasification plant at Puthuvypin. In addition, an International Bunkering Port is also proposed to be set at the southern end. This bunkering port will have a system of breakwaters to shield the vessels from wave action – a western breakwater at the southwest tip of Puthuvypin, and an ‘island-breakwater’ south of the Kochi Channel. A modern dry dock and ship repair yard have also been planned at Puthuvypin. In sum, a lot of investment running into several thousand crores of rupees is being made in this part of the country!

Vallarpadam

The island of Vallarpadam – an ancient landscape, unlike Puthuvypin – lies east of Vypin. Plans to build a container terminal here have been on the anvil for a very long time now with about 400 acres being earmarked for the project. The terminal is designed to handle container-carriers drawing up to 12.5 m. The alongside berths would, therefore, require capital dredging to create depths of 14-15 m. The dredging will have to extend right up to the main navigational channel to facilitate entry and exit of vessels. A bridge has already been built connecting this island to Ernakulam, for the container transshipment to the railhead at Ernakulam. Apparently, the work on the container terminal has just begun with the commencement of capital dredging.

Figure 1 shows the location of the Puthuvypin-Vallarpadam port project. Now, a more pertinent question arises: will the dredging, capital and subsequent maintenance at Vallarpadam berths impact the sediment dynamics regime at Puthuvypin?

Ports and Shelter

Before discussing the sediment dynamics regime, let us consider a mundane aspect that may have serious repercussions on Puthuvypin’s long-term viability. With no natural

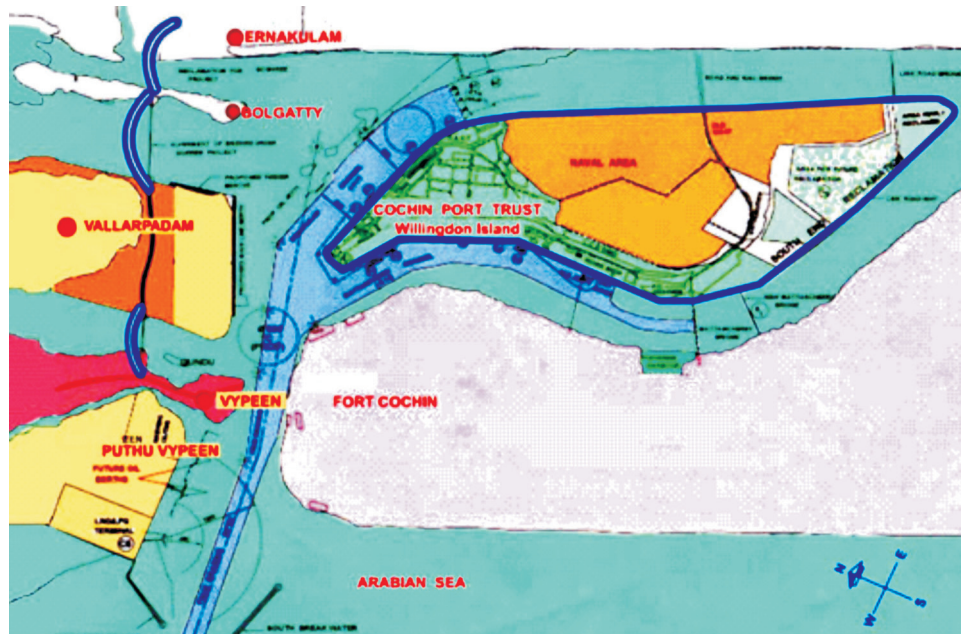


Fig. 1. Proposed Puthuvypin-Vallarpadam port project.

shelter, Puthuvypin is exposed to the onslaught of the salt-laden Southwest Monsoon winds, which lash the shoreline for nearly one-third of the year, from May to September. Corrosive salt-laden winds, blowing steadily on to the port's steel structures, for four months every year, can be devastating.

Anyone who has sailed along India's West Coast would have noticed the conspicuous absence of constructions right on the shoreline. There are a few buildings and structures near the sea, except for lighthouses. All coastal construction remains hidden behind the lush green foliage to protect the structures from the windy onslaught. The maintenance cost of buildings and structures exposed to salt-laden winds can be prohibitive.

Every port on the West Coast, capable of year-round operation, is either situated inland within sheltered estuaries, such as Mumbai and Kochi, or is shielded by huge promontories or headlands, such as Mormugao and Karwar. New Mangalore Port, the only exception, is also not snug on the coast, like Puthuvypin, but in an artificial lagoon located a short distance inland. Every other port on the West Coast, without natural shelter from the onslaught of monsoon winds, operates only during the fair weather, the non-monsoon months, from mid-September to mid-May. Natural shelter,

therefore, is vital for a port that is meant to operate all year round. Alternately, huge maintenance costs and operating limitations would need to be factored in. One can therefore ask: is Puthuvypin designed for year-round operation?

Consequences of the Lack of Shelter

The impact of monsoon winds, year after year, on Puthuvypin may have devastating consequences. The port's steel infrastructure, particularly the storage tanks, will be subject to serious corrosion damage, which in turn will warrant expensive maintenance, every year. What would happen if the maintenance effort does not somehow keep up with the corrosion damage, for whatever reason? We all know that can happen. The tanks holding several hundred tonnes of petroleum crude could be at risk. Has anyone considered the consequences of one of the tanks cracking up and spewing its contents?

Sediment Dynamics Regime

Puthuvypin, in the present form, did not exist about 30 years ago. It has been formed recently by the deposition of sediments. But what caused this rampant sedimentation, which created so much land in such a short time? Let us see how the process works, how sediments reach the Vypin shoreline, and cause it to grow into Puthuvypin.

The first question that arises is where do the sediments come from? Some experts believe that the sediments originate at sea and are brought to the shore by waves. This is quite preposterous, because nothing in nature gets transported against gravity, unless pushed up by tectonic forces. In this case there is no tectonics, only gravity. Sediments along the coast, and on the sea-bed, often several kilometres thick, originate on land. There can be no other sediment source, but land.

During the Southwest Monsoon, the adjoining hills receive very heavy rainfall. This falling rain is the principle agent of erosion of the hills, of course, aided by other agents such as solar heat, action of plant/tree roots, burrowing animals, and human action – agricultural activities, quarrying, mining, and even deforestation. The resulting runoff, flowing through several rivers and streams, brings large quantities of eroded sediments into a huge water body – the Vembanad Backwaters – located south of Kochi. Vembanad cannot contain the inflow of water and sediments during monsoon. It discharges most of that to the sea through its only visible opening, the Kochi Channel.

The bulk of these sediments flow out to sea, through the deeper Ernakulam Channel, which runs between Ernakulam mainland and Wellington Island (Fig. 2). This sediment outflow happens in three distinct sediment streams, based on the velocity and depth gradient. The main sediment discharge follows the deeper section, the middle of the Channel. Let us call it the *mid-stream*. The mid-stream carries its sediment load, mostly silt and soft mud, unimpeded to the sea and, on the way, a tiny portion of it ends up silting the Channel.

The other two sediment streams follow either shoreline of the Channel, that is, on either side of the mid-stream. The sediment loads in both these streams contain sand. One flows along the Ernakulam mainland, Bolghatty and Vallarpadam, to finally reach Vypin's western shores. Let us call it the *Vypin-stream* as it supplies sediments that contribute to Vypin's seaward growth. The other stream flows along Wellington Island, which is also joined by a smaller sediment stream that comes in through the Mattancheri Channel. Together as one, this stream flows on to Fort Kochi shoreline. We can call it the *Fort Kochi-stream*, since it used to replenish the once beautiful Fort Kochi beach.

Understandably, to permit smooth flow of both these sediment streams, the shorelines on either sides of the Channel have been maintained reasonably obstruction

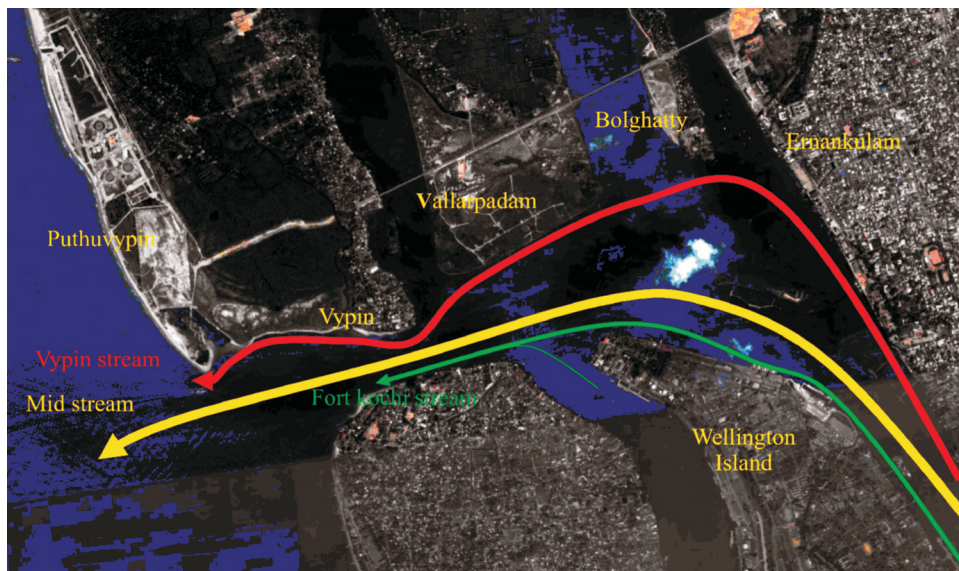


Fig. 2. Sediment regime at Kochi; sediment streams.

free. All man-made features on the shoreline, such as the Indian Navy's (IN) old IN jetty and Boat Pool on the Wellington Island, the tanker berth on the Ernakulam shoreline, and other small jetties that operate passenger craft, have been built either on stilts or piles, to enable free, unimpeded flow of sediments (Fig. 3).

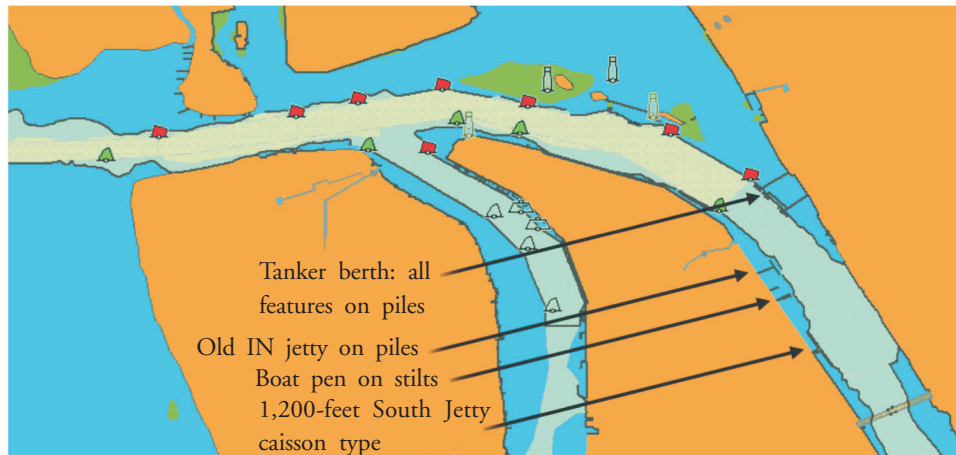


Fig. 3

Erosion of the Fort Kochi Beach

Around the same time that the shoreline sediment streams – *Vypin* and *Fort Kochi* – begin to supply sediments to their respective shorelines, high intensity monsoon waves begin to act on these shorelines. Contrary to popular understanding, these incoming big waves actually do little harm to the shoreline, but help push the sediment load of both these streams on to the respective shores. After each wave pushes the sediments and crashes onshore, it runs back to the sea along the bed, which is known as *wave-water runback*. It is this *wave-water runback* that scours the coast and carries away the coastal sediments back to the sea. However, it does not take away all the sediments that the wave pushes onshore. A small portion of the freshly brought in sediments remains onshore. Hence, both Fort Kochi beach and Vypin coast have grown seaward every year, very slowly and naturally, in a hardly perceivable manner.

This slow growth of both Fort Kochi beach and Vypin coast went on unnoticed till the mid-1980s, when the former began to erode rapidly. The Fort Kochi beach has

since disappeared and its place was taken by a seawall, purportedly built to prevent further erosion of the shoreline.

Some experts believe that the increase in wave action was mainly responsible for the erosion of Fort Kochi beach, and erosion elsewhere along Kerala coast. But this too cannot be true, as there has been no measurable increase in monsoon wave action anywhere along the Kerala coast, let alone at the Fort Kochi beach, since a very long time. Obviously, something else altered the sediment dynamics regime at Kochi, which cut off sediment supply to Fort Kochi beach. But how did it happen?

1,200-foot South Jetty

Around the early 1980s, IN decided to build a new jetty, south of the old IN jetty – the 1,200-foot South Jetty. The Pune based Central Water and Power Research Station (CWPRS) designed this new jetty. They came up with a caisson-type jetty, unlike anything else on the Channel's shorelines. This design is very cheap as compared to the one that stood on piles. But, of course, it would not allow any sediment to pass through. Obviously, CWPRS paid little heed to the sediment dynamics regime in the region. But why did they do so? One can only speculate.

The sediments discharge through Kochi Channel took place only during the monsoon and there was none during the eight-month long non-monsoon season. However, this needed confirmation through fieldwork before designing any coastal structure in the region. Fieldwork was a problem during the monsoon, because of heavy rains and swift currents in the Channel. But during the long non-monsoon period, it was very easy. Hence, most investigative studies make do with data collected during this period of fair weather, and then extrapolate for the 'just' four-month long monsoon period. CWPRS seems to have also done the same. In the absence of sediment flow during the non-monsoon season, the extrapolation into the monsoon months would result in a similar conclusion, even if the ground realities are very different.

If there is no sediment flowing along the shoreline, a caisson-type jetty would ideally fit the bill. It is also cheap and very easy to build. Perhaps, this is why the caisson-type 1,200-foot South Jetty was built. Over time, however, the upstream of the jetty, towards the south, began to silt up with no sediments getting past the jetty. The *Fort Kochi-stream* that flowed along the Wellington Island shoreline and, in turn,

went on to supply sediments to the Fort Kochi beach, was cut off. Thus, the sediment supply to the beach stopped.

Now, when the big monsoon waves began lashing the beach, there was no sediment to be pushed onshore. But the *wave-water runback* continued with its natural task – scouring away coastal sediments and carrying them off to the sea. As a result, the beach began to erode. In a matter of a few years, the entire beach was gone. To prevent further damage to the shoreline a seawall was built. The experts took turns to blame the sea waves for eroding the famous Fort Kochi beach. They called it *Kadalakramanam*, which means “attack by the sea” in Malayalam, while the real attack was taking place much upstream, at the 1,200-foot South Jetty.

If the jetty is removed and the original shoreline is restored, the Fort Kochi beach will simply grow back in a few years. But that is easier said than done. Alternately, a mechanism could be set up to pump sediments during the monsoon from upstream of the jetty to a point downstream. From there on the natural flow can take the sediments forward, thus, mimicking nature’s sediment transport process. Of course, detailed modelling studies would be a pre-requisite to establish the correct location to artificially deliver the sediments, so that they can be carried forward naturally.

Growth of Vypin

Since the object of interest is Puthuvypin, one may wonder at the concern expressed over the erosion of Fort Kochi beach. Well, both are connected by the same sediment dynamics regime. The 1,200-foot South Jetty stopped the *Fort Kochi-stream* in its track, but it does not mean that all sediments stayed put at its upstream. They had to flow out at about the same velocity and depth gradient as before. Soon, the sediment stream, which would have otherwise flowed along the Wellington Island, traced a new course through the silted up area in the upstream of the jetty, only to flow along the opposite shoreline and join the *Vypin-stream*. Thus, the sediment load of *Vypin-stream* and, in turn, the sediment supply to the Vypin shoreline practically doubled. The incoming waves now pushed much more sediments to the Vypin shoreline, while the corresponding process of sediment removal by *wave-water runback* remained normal. Vypin, thus, began to grow rapidly, faster than ever before. Soon Puthuvypin was formed.

Effect of Puthuvypin's Growth

So long as the status quo is maintained in the sediment dynamics regime at Kochi, Puthuvypin will continue to grow seaward. What does that mean for the project? As the shoreline grows seaward, the adjoining sea would surely become shallower. This would pose problems for vessels approaching the shore. There are two options to resolve this situation. One is to keep dredging to maintain the necessary depths close to the coast, so that vessels can continue to approach the existing mooring stations. But the dredging will alter the sediment dynamics in the region and the consequences could be very serious, because the region is geologically fragile. The other option is to relocate the 'moorings' seaward to deeper waters and, correspondingly, lengthening the pipelines. This is both expensive and time consuming. Thus, it is really a choice between "the devil and the deep sea". One wonders whether the concerned authorities have applied their mind to this possibility?

Consequence of Altering the Sediment Dynamics Regime

What would happen if the status quo of sediment dynamics regime cannot be maintained, and the sediment supply to Puthuvypin is either reduced or cut-off? Quite simply, if and when that happens, Puthuvypin will begin to erode and it may soon disappear, just as quickly it came up or, perhaps, even faster. But what could upset the sediment dynamics regime, so as to cut-off sediment supply to Puthuvypin?

Nemeses of Puthuvypin

Puthuvypin has two nemeses, which are actually parts of the proposed design of the Vallarpadam container terminal and the international bunkering port.

The *Vypin-stream*, as of now, flows along the shallow regions adjoining Ernakulam mainland, Bolghatty and Vallarpadam, before reaching Puthuvypin. But when the container terminal comes up, the alongside berths will have to be dredged to depths of 14-15 m, as against the prevailing depths of 1-3 m. There will not be any shallow left for the *Vypin-stream* to transit across Vallarpadam to Puthuvypin. Hence, its sediment load will simply sink into the dredged portion. A part of this sinking sediment load will silt up alongside the berths and the rest would flow out to sea via the main Channel, that is, along the *mid-stream*, without touching Puthuvypin. When that happens, Puthuvypin will begin to erode just as it happened to Fort Kochi beach.

The effect will be noticeable during the very first monsoon ensuing the dredging of Vallarpadam's container berths.

Another nemesis waiting to take shape is the western breakwater of the proposed bunkering port. This will prevent whatever little sediments that may get past Vallarpadam from flowing across and replenishing the western shores of Puthuvypin. As a result, the incoming waves during monsoon will not have sediments to push onshore, while each *wave-water runback* will scour away sediments from the shore. This would signal the beginning of the end for Puthuvypin – the proverbial last nail on its coffin.

Solution: Seawall?

Once Puthuvypin begins to erode, the easiest solution that will invariably come to the minds of all concerned will be to erect a seawall. It is also something that conventional wisdom would dictate. In fact, seawalls are recommended by reputed coastal geologists, scientists and engineers; even those from the Centre for Earth Science Studies (CESS), Thiruvananthapuram and CWPRS. A seawall is cheaper to build with little involvement of high technology. Seawalls have already been built along several eroding stretches of the Kerala coast.

However, a seawall is an aberration on the shoreline, which is meant to remain soft, as per nature's design. Hardening it by a seawall does not really solve the problem, but only defers it slightly. Invariably, in all cases without exception, the real cause of erosion lies elsewhere. Hence, the solution needs to be put in place there and not along the eroding shoreline.

What happens when a seawall is built along an eroding shoreline? It makes some contractors rich and spoils the natural beauty of the coastline. Actually, nature's erosive processes do not cease at all. Contrary to popular belief, it is not the crashing big wave that damages the sandy shoreline, but the *wave-water runback*. The seawall may be sturdy enough to withstand the incessant onslaught of big waves crashing on it, but it remains powerless against the *wave-water runback*. After every big wave crashes on the seawall, the wave water runs back down along the seawall to the seabed before flowing back to the sea. During this runback, it scours away sediments from the seawall's base and carries them off to the sea. Over time, sufficient sediments would get squirreled away and portions of the seawall may collapse and even disappear underwater. This keeps only the contractors happy as they get to rebuild the seawall and, in the process, make more money.

In addition to this downward flow each time a wave crashes on the seawall, some amount of water trickles through the crags between the boulders that make up the seawall, going down all the way to the soft portion of the coast on which the seawall rests. Even this water must flow back to the sea and it normally does so through the same crags at the base of the seawall. Each such outflow also squirrels away tiny quantities of sediments back to the sea. Bit by bit, unceasingly, sediments landward of the seawall get removed. This causes the hinterland to slowly deplete, sink and become water-logged. This is happening at many places where seawalls have been built, even at IN's Gunnery School, INS *Dronacharya* adjoining the Fort Kochi shoreline. Therefore, a seawall is not a real long-term solution to the problem of erosion.

Is there a Future?

Preventing Puthuvypin from eroding after the dredging at Vallarpadam is complete and, later on, when the bunkering port's western breakwater materialises, is going to be difficult. The seawall may not be adequate to manage the situation. New techniques need to be quickly evolved to deal with the problem. Moreover, the spectre of global warming and the consequent rise in sea level looms menacingly to further complicate the matter. The issue of corrosive salt-laden winds also remains unresolved. Is there a future to Puthuvypin? This question continues to be pertinent and pressing.