Source: *The Business Times,* p20
Date: 5 November 2020

Floating farms are a prelude to floating cities

Floating farms can secure the food supply chain of coastal cities. Build them right, and the world can look towards building sustainable floating cities as well. BY JAN WILLEM ROEL

FLOATING farms can secure the food supply chain of coastal metropolises and open up the possibility for the development of floating cities. With rising sea levels, coastal subsidence and a growing global population, floating farms are the first step in securing the future of coastal cities across the world.

The opportunity is particularly meaningful in Singapore, which is striving to establish its food security and source 30 per cent of its nutritional needs domestically by 2030. The city-state can serve as a testbed for the development and deployment of floating farms for aquaculture or other forms of agriculture at scale.

Currently, 9 per cent of fish consumed domestically are sourced from offshore farms termed *kelongs*. However, these are designed cheaply and do not adhere to formal structural design codes. They are also not optimised for large-scale production of fish protein, while also being exposed to environmental threats like algal blooms.

Using expanded polystyrene (EPS) as a buoyant foundation, with concrete plates layered on top, modular floating farms optimised for aquaculture or other agricultural methods can ensure food security for coastal cities. EPS-concrete floating structures are thus an economically sensible solution that also open inroads into developing floating cities.

The amount of land given to providing food, water, energy and to absorb waste has been in decline. One solution, Canadian research says, is to take farms offshore. PHOTO: BLOOMBERG

Carbon-neutral floating farms

The United Nations Food and Agriculture Organization (FAO) estimates the world population will surpass 9.1 billion by 2050. At this point, agricultural systems will have insufficient production to feed everyone. Humanitarian organisation Oxfam has also predicted that a growing world population will exceed food-growing capacity in 2050. This is compounded by climate change, crop failures and rising food prices for staples like corn and rice.

According to research from the University of British Columbia, the global ecological footprint – the area of the Earth's surface required to support a population's lifestyle with water, energy, food and resources and waste absorption – has been in decline since 1900. Hectares of land per capita has declined since 1900, decreasing from 7.91 hectares (ha) to 2.02 ha per capita in 2005. This is forecast to reach 1.69 ha in 2030 and go down further to 1.44 hectares in 2050.

One solution to mitigate this coming crisis is the use of floating farms built using EPS-concrete hybrids. Such floating farms offer environmental and economic advantages; they are carbon-neutral, as EPS can be sourced and recycled from plastic waste.

EPS is generally non-biodegradable. Often used in various construction, consumer and industrial applications, its inability to biodegrade is perceived as a negative environmental factor. But this can also be beneficial, as it cannot contaminate the environment with gases and is easily recycled.

The manufacture of polystyrene, formed from styrene and pentane reacting, generates minimal pollution. The main source of energy comes from steam. Water consumption is very low as the water is often recycled many times. Minimal waste is generated as any cut-offs or rejects are reused. Once the process has been completed, EPS has just a 2 per cent polystyrene cellular matrix; the remaining 98 per cent is air. To illustrate this, the density of EPS is 0.25 kilonewtons per cubic metre, compared to water, which is 10 kilonewtons per cubic meter.

The 2018 US EPS Recycling Report estimates that over 51.25 million kg of EPS were recycled in 2018, comprising 18 million kg of post-consumer packaging and 33.6 million kg of post-industrial packaging. The 2018 Canadian EPS Recycling Report shows 2.8 million kg post-consumer and 3.9 million kg post-industrial EPS was recycled.

Very large floating structures (VLFS) built using concrete are generally 35 per cent cheaper than steel constructions. The use of concrete composites using expanded polystyrene (EPS) is between 40 per cent and 65 per cent cheaper than steel equivalents. This is coupled with reduced maintenance costs over the life cycle of the structure, reduced vulnerability to sinking; and greater environmental friendliness.

They can be made even more ecologically friendly with the integration of solar-photovoltaic subsystems, as well as water-recycling systems, and even airborne wind turbines tethered to these floating structures. Running on renewable energy, these farms would be self-sustaining and not need to connect to mainland grids, producing food in a carbon-neutral and sustainable manner.

Floating cities

Floating farms also serve as the foundation for floating cities. UN-Habitat predicts that by 2035, 90 per cent of all mega-cities – metropolises with over 10 million people – will be on the coast. Yet these will be threatened by rising sea levels or land subsidence, which Jakarta and Bangkok are currently experiencing.

The report titled "Future coastal population growth and exposure to sea-level rise and coastal flooding-a global assessment", published in 2016 by PLOS ONE, notes that low-lying coastal cities are under severe threat from rising sea levels, which exacerbate flooding and storm surges.

C40, a coalition of global megacities committed to addressing climate change, estimates that by 2050, more than 570 low-lying coastal cities will face projected sea level rise by at least 0.5 meters, putting more than 800 million people at risk from the impacts of rising seas and storm surges.

Global economic costs could easily amount to US$1 trillion by 2050, with cities on the east coast of the US and coastal metropolises in Asia particularly vulnerable.

For land-scarce coastal countries like the Netherlands and Singapore, which lack hinterlands for their people to retreat to, the use of VLFS is a meaningful alternative to land reclamation and even polders, given that global sand reserves are being depleted and making landfill reclamation more expensive and costly.

Land reclamation is environmentally hazardous, destroying natural ecosystems and depleting the natural capital of coastal metropolises. For instance, destroying mangroves that protect against shoreline erosion will cause sea currents to erode beaches and alter coastlines. It also affects local fisheries, changing entire ecosystems.

Such activity is unsustainable. With the need to enhance food security and localise supply chains of critical food products – reinforced by the shocks to global supply chains from the effects of the coronavirus pandemic – floating cities offer an alternative.

Floating structures can also protect the marine environment. Unlike reclaimed land – created through polders or the landfill method, which require a multi-year waiting period for sediments to settle before it is safe to build on – floating cities can be built on once a platform is anchored. Floating structures can also be easily moved to other locations as urban planning needs evolve.

Many floating city models are being tested and proposed worldwide. In the Netherlands, a company called WaterStudio has already built small-scale floating buildings. The French architecture firm XTU evolved a floating city concept called X SEA TY, and architect Vincent Callebaut has designed a floating city called Lilypad, which can house 50,000 people in high-rise towers resembling lily pads.

For maritime nations like the Netherlands and Singapore, floating cities represent a compelling opportunity, as platforms for future growth and ensuring the continuity of their economies and societies in a world of rising sea levels.

But the foundation for such a future must be grounded with a focus on economically sensible floating farms and the security of the food supply chain that it creates.

▮ The writer is the principal of FlexBase BV and co-founder of FlexBase International. The piece is co-written with Dominic Kang and Paul Ong. Mr Kang is a civil engineering graduate of the National University of Singapore (NUS). Dr Ong is a senior lecturer in the Department of Civil and Environmental Engineering at NUS.