To The Sea

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Aeolia was approaching California. The floating island was drifting slowly eastward on the North Pacific current, and was nearly in view of the USA once again. The top floors of the tall buildings at the eastern end of the island were full of people wanting a first glimpse of land after more than two years in the deep ocean. Michael and Grace Humboldt, with their grandsons Martin and John, had joined the crowd. It was early afternoon on a sunny summer day, 27 August 2041. Visibility was perfect. California gradually hove into view, right on schedule, coming up in the east like the sun at dawn. "Land ho" called a voice. All eyes focused on the smudge of brown and green on the eastern horizon.

It was two years since Aeolia had left Japan. Travelling only slightly faster than the sedate fifteen kilometres per day of the current, the giant island was now on its fifth circuit of the North Pacific Ocean since its launch from Papua New Guinea in 2015. Michael Humboldt was returning home after six years away. He was looking forward to a month or two on land while the island slowly made its way down the California coastal current. Humboldt was born in San Francisco in 1982, well before the oceans started their sudden rise. He wanted to see for himself how the old coastline he knew so well had changed, now that the waters of the Pacific were three metres higher.

The problems of sea level rise and climate change had been the big stories of world politics for decades. There was nothing like seeing it with your own eyes to understand the impact. Around San Francisco, the early decision had been made to abandon low lying ground and instead focus on the move to the sea. The decision was forced when people accepted that the cost and risk of walling in the old coastline was simply too great. The big San Andreas quake of 2023 made everyone see there was no choice. The danger of levee failure would have only grown worse as the ocean continued its inexorable rise, as London and New York were discovering. Michael thought of the old beaches and ports he had grown up with, now lost forever under the waves. He looked forward to checking out the submerged coast and the old cities, and catching up with friends who had not yet made the move to the ocean. San Francisco was relatively okay compared to New York or New Orleans, where massive new levees made you feel like King Canute standing against the power of the tide. And poor places like the river deltas of Bangladesh and Vietnam were now under the sea, creating immense problems.

Michael Humboldt was a civil engineer and inventor. He had led the team which designed and built Aeolia, the first of hundreds of floating islands now dotting the oceans of planet earth. Michael had lived on Aeolia for twenty five years, since soon after the decision to colonize the oceans as part of the response to climate change. The decision had proven farsighted. Global warming and sea level rise had arrived with bigger, faster and more furious impacts than anyone had really imagined. It looked like the move to the sea would be permanent. We are the new whales, Michael had once said, reflecting on the gradual evolutionary shift of the cetaceans from land to sea some fifty million years ago. Humans might not grow fins and take to the water, but we would use technology to colonise the ocean.

Michael and Grace had met and married on the island of Aeolia where they now lived with their children and grandchildren. As the inventor of the ocean dam, Michael Humboldt was a famous man, author of the biggest idea of the twenty first century. Grace Humboldt was the bio-fuel scientist who had led the development of sea-based agriculture. Their close professional partnership had made a personal relationship seem natural too. Together, they were at the centre of all the big technical decisions about building ocean dams - water sourcing, water use, dam design, transport around the world ocean, agricultural options, industry, etc. Michael tried to avoid the political and religious debates caused by the move to the sea, but of course the big technical decisions were all highly political, affecting the ability of nations to respond to climate change. The truly amazing thing was how a relatively simple technical idea could drive such transformation of the world's political, economic and ecological systems.

The freshwater ocean dams beneath Aeolia were steadily growing in size as new water was harvested from the continual rain of the North Pacific. The dams now held forty teralitres in the vast fabric sacks beneath the ocean surface. Aeolia's main dam was three kilometers deep under the central square of the city, and was surrounded by an ever-growing number of new shallow dams. Thinking in teralitres – cubic kilometers or trillions of litres – was a massive scale compared to the old land based water supply technologies. Even a teralitre was still tiny against the mighty size of the world oceans.

115 million square kilometers of planet earth is covered by water, at an average depth of 3.8 kilometres. The oceans occupy more than 71% of the planet's surface, containing roughly half a billion cubic kilometres of water in total. Michael liked to muse about these orders of magnitude. The world was adding one teralitre of ocean dam per day. He had once calculated that at the current rate it would take the best part of half a million years to cover the whole ocean with fresh water to a depth of one kilometer, not that anyone would ever want to do that. Planning for the next fifty years was more than enough.

Michael and Grace and their young grandsons Martin and John had left the underwater train station at the eastern end of Aeolia and were strolling down the forest path to the high eastern tower. It was a beautiful warm sunny day with barely a cloud in the sky, perfect for long distance viewing. The boys had not seen land since they were both toddlers, and they had been looking forward to the outing for weeks. Michael was also looking forward to it, but more because he had promised the boys that he would explain to them how the island worked. He wanted to see if he could explain the basics of the island so simply that a six year old could understand. The boys had raced ahead, impatient for their first view of land. Both were now at school and were full of curiosity about everything. As Michael and Grace caught up to them at the tower entrance, young Martin opened the conversation, "Grandpa, why don't we live on the land?"

Michael wanted to explain the basic principle of Aeolia, that fresh water floats on salt water. "You remember those icebergs we saw last year near Alaska?" he began. "There are two reasons why they float on the sea. First, they are made of ice, and ice floats on water like ice cubes in a glass. If ice sank the whole sea would freeze solid. And second, icebergs float because they are made of fresh water which fell in to the sea from big ice rivers called glaciers. Fresh water floats on salt water. So our island floats like a big iceberg made of fresh water held in a big bag. And we live here because it is the best home on earth."

They continued talking as they left the elevator at the top of the tower. The crowd was buzzing, and there were too many there for the latecomers to get to the window for a clear view of the horizon. The boys would have to take turns to sit on granddad's shoulder to see over the heads. Grace listened quietly as Michael told his story, with occasional questions from the children. She had heard him tell it many times before, and once again she heard the excitement in his voice. She knew their island home would always seem slightly miraculous to him, as it did to so many people around the world. A few other people had now recognized Michael as he talked with the boys, and had gathered to also listen, though they already knew the basics of what he had to say.

Michael explained the mythological roots of the name of their island. Aeolia was named after the floating island described by Homer in the Odyssey, the ancient story of the travels of the hero Ulysses home to Ithaca from Troy around the Mediterranean Sea. Homer wrote: *"Next we reached Aeolia, a floating island, where Aeolus lived, son of Hippotas, whom immortal gods hold dear. Around it runs an impenetrable wall of bronze, and cliffs rise up in a sheer face of rock."* Some people liked to imagine the old Aeolia as the last remnant of the ancient sea-based civilization of Atlantis which was destroyed in the cataclysm we call the flood, around 7000 years before Christ. Some even believed the civilization of Atlantis was built on floating islands in the open ocean, and these were lost without trace in the flood, apart from the hidden remnants of their high technology in the pyramids of Egypt. Whatever the truth behind these myths, Aeolia was a good name for the first modern floating island.

He briefly summarized how the island works. Each ocean dam was surrounded at the ocean surface by a solid barrier, like the bronze wall of Aeolia described by Homer. The modern surface barriers were made of reinforced concrete. The barrier had to be strong and stable to withstand storms and protect the dam from the ocean. The dam itself was held in a flexible fabric sack under the water inside the surface wall. This sack was like a big wine cask, an impermeable sub-surface container enclosing fresh water at depth below the level of the waves, in the deep stillness of the ocean. The fabric of the dam had to be strong enough not to tear, and needed replacing after about five years as it naturally deteriorated in the harsh ocean conditions.

This was about as much as the boys could handle for today. Michael suggested they talk with their friends at school about the dam, and think about any questions they had for him. They raced off, and managed to squeeze through the crowd to get close to the high glass windows, where the US coast was becoming a distinct line across the eastern horizon.

The simple principles of ocean dam technology had led to the biggest change in human history. Once people started to really explore the possibilities of the basic principle that fresh water floats on salt water, a whole new age had begun, wetting down the earth, managing and restoring the global climate, taking pressure off ecosystems of land, sea and air, using the ocean currents like arteries, and making good use of the seventy one percent of the globe that was covered by ocean. A new skin was being added to the earth, a hydrosphere, a steadily growing lens of fresh water in between the atmosphere and the earth, protecting the planet like the rind protects an apple. Some thought it ironic that the new age of Aquarius was really turning out to be the time of the water bearers.

The invention of the ocean dam had transformed the planet. These immense new structures floating in ocean water, containing fresh water and relying on net buoyancy for flotation, were now being built in sizes up to many cubic kilometers. The Amazon River was especially productive. One percent of its flow was captured in big pipes at the river mouth to create a new cubic kilometre dam every week. The Amazon, with annual flow of 5000 teralitres, provided one quarter of total world river flows and was by far the biggest source. The Congo, the Orinoco and the Yangtze came in next with 13% between them, followed by another thirty rivers each flowing at a rate of more than one hundred teralitres per year. Between river flow and ocean rain harvest, dams were now being filled at the rate of one teralitre per day, with entirely beneficial environmental impact. Twentieth century ideas about terraforming Mars had given way to realization that priority should go to the immense project of transforming our own blue planet. Just as control of petroleum had been the big prize of the world economy in the twentieth century, fresh water was proving the vital commodity to lubricate world politics in the new millennium.

The optimum dam depth for residential tower construction was two hundred metres, allowing each cubic kilometer of captured fresh water to provide for up to five square kilometres of new housing, often in towers one hundred stories high surrounded by parks. Agricultural land was being built on ocean dams as shallow as twenty metres, mainly for biofuel production and carbon capture using algae. As a result, the world was beginning to restore the atmospheric balance that had been so badly distorted by fossil fuel carbon emissions. A teralitre of new water could provide for fifty square kilometers of agricultural land, and the new methods of hydroponic horticulture were putting this new land to full productive use. The phase-out of fossil fuels began in 2018, and it rapidly became apparent that petroleum was far too valuable and dangerous to burn. Between carbon taxes, climate impact, abundant renewable energy and the high value of plastics, it was hard to believe the twentieth century had squandered petroleum and coal so wantonly.

The new Aeolia was now approaching forty square kilometers in size, and was a very pleasant place to live, despite the high population density. The best thing about the new lands in the ocean was that their new technology and political systems had made them immensely wealthy. There was plenty of parkland and different things to do around the high apartment towers. And with new islands being built every day around the world, the variety of places to visit was becoming almost unlimited, including wildlife refuges, airports, sporting and cultural centres, and of course the immense agricultural fields.

Michael had supported the decision to base Aeolia permanently in the North Pacific Gyre. Now that they were beginning to make their way down the California coast, he was looking forward to the repeat of the old debate about whether to turn west at Los Angeles and head across to Asia again, south of Hawaii, or whether to set all the giant propellers on the western wall and push the island into the Central American current past Mexico and along to Colombia, and then head southwest on the current to Tahiti, or further west to New Jerusalem or on to Australia. Changing course was still only favoured by a small minority on the island, but a decision would be needed within the year.

There were big reasons not to leave the North Pacific. Repeating the visits to East Asia and the USA provided a regularity and stability in the life of the island and its evolving economy and ecosystems, especially regarding the valuable water trade to California and China and the management of the North Pacific biofuel plantations. An island with a dam as deep as Aeolia had not yet traversed the equatorial route from North to South

Pacific, and Aeolia's forests had been chosen to cope with warm years traveling west along the equator followed by cool years traveling east from Japan past Alaska.

The argument for heading south this time was that most of Aeolia's deep water could be sold in California, reducing the island depth to about one kilometre. But Michael Humboldt did not agree. If others wanted to take off to the Southern Ocean or up the Atlantic, they could pod off a small island from Aeolia's island construction port and good luck to them.

A key to ocean dam technology was a mechanism to increase the depth and volume of the dam by adding flexible material to the sub-surface barrier. Several approaches to this mechanism were in operation at different dam sites. Some used a seamless fabric bag, like a plastic bin liner. Others used straight fabric walls connected at each corner by zippers to enclose the fresh water in the dam. Michael liked to compare these options to the Cambrian evolutionary explosion 540 million years ago, when dozens of weird and wonderful creatures evolved, only to be out-competed by those which were most adaptive to the earth's ecology. Time would tell what the most adaptive designs would be for ocean dams.

The boys had returned by now, and Michael was talking with them about all this in much simplified terms. As they listened, the story caught their imagination and they forgot about the slowly expanding view to California. Martin, the older boy, was now seven. He came up with the next question, "Grandpa, have any dams ever sunk?"

Michael explained that the biggest problem had proven to be tsunamis. All dams were built to withstand a one in a million year storm, so hurricanes and tornados just blew over the top. Collision with sea mounts or islands was easily avoided by the dam's steering systems now that all the oceans were fully mapped. After several early dams were ruptured by tsunamis, the prediction and response systems were upgraded so only the biggest seismic event, like a repeat of the San Andreas quake, would cause a dam unlucky enough to be directly in its path to sink. With a few hours warning, shallow emergency dams could be put in place to take the brunt of the shock wave and avoid serious rupture of the sub-surface fabric, and emergency repair systems were now good enough to mend any tears before the surface started to sink.

Some thought maybe it was a series of giant tsunamis that had wiped out the ancient civilization of Atlantis. Michael was rather old-fashioned about this sort of talk and preferred to stick to empirical scientific topics rather than speculation about mythology.

Dams were segmented so that a tear in underwater fabric could not cause failure of the overall structure. It became standard practice in islands such as Aeolia for the dam to be built on a modular basis. Once a surface wall was built it had a single dam under it, often with internal dividers. As new adjacent lands were added, they had their own self-contained dams, as much for practicality of construction as for any risk of failure. The deep ocean is only stormy at the surface, so the fabric was at more risk from barnacles than from weather. Monitoring and maintenance systems were needed to prevent deterioration and failure, including sensors on internal and external walls of the surface and sub-surface barriers. It became an established practice to use crops grown on shallow dams to make fabric for the sub-surface dam walls. New fabric was continually added, and the old barnacle encrusted fabric at the bottom of the dam was recycled into the solid outer walls of new dams.

The first prototype ocean dam, built by Michael Humboldt off the east coast of Australia in 2010, was twenty metres in diameter. The chosen site was in the open ocean, just off the continental shelf in water about two kilometers deep. The surface wall was a circular concrete ring with steel rod reinforcing, curved in at the top like an upside down J. The outer wall was fifteen metres high, and the inner curve of the concrete came down about five metres from the high point of the wall. A big rubber inner tube full of air sat inside the ring to float the concrete while the dam was filled. The process to fill the dam with fresh water began by laying a big round sheet of waterproof fabric on top of the ocean inside the ring. This sheet was protected from the waves by the concrete ring which moved up and down with the swell. Fresh water was barged to the dam from the nearby Hunter River, and pumped on to the sheet. A continuous vertical cylinder of fabric was stitched to the circumference of the base sheet where it met the inner concrete wall, holding the fresh water in an impervious flexible container. As the volume of fresh water pumped in to the dam increased, the base sheet was lowered into the ocean. More and more fabric was added to increase the height and width of the cylinder until the base was one hundred metres under the surface. The fabric bag expanded to fifty metres in diameter below the surface, holding a volume of almost two hundred megalitres of fresh water. Once the dam was filled, the fresh water container was stable enough to support the concrete surface barrier, and to enable construction of a stable platform on top.

After this prototype was successfully built, interest in the new idea exploded. The next big event floated a cubic kilometre of water from Milford Sound in New Zealand around Antarctica to Perth in Australia. The benefit of this approach was that the only real cost was the dam construction, as the ocean current provided the energy for transport. The unit cost was way below desalination, completely changing the economics and politics of the water industry. Big new water storage dams, sourced from New Zealand, became permanent features of the ocean near Perth and Adelaide, providing a big economic boost after the uncertainty of the previous reliance on land based technology. Fresh water from New Zealand was now filling Lake Eyre in Central Australia.

A series of failed wars in the early twenty first century had led to widespread anger at the military approach to security, while also creating interest in realistic alternatives. The political demand was for practical ways to cooperate peacefully on a global basis. Ocean dams fitted the bill perfectly, now that much of the money formerly used for weaponry was directed to the real security threat posed by global warming.

There were so many areas to research. Some of the main fields were water transport and treatment, controlling movement of the dam in the ocean current, and use of energy from sun, wind and waves to speed the island’s movement, power its industries and capture carbon. Most of the world’s biggest rivers now had pipelines out to sea to capture excess water in ocean dams. The inlets were placed at sufficient height to only take river water when flow rose above a defined level. There was no need to take water from a river if it might harm the local ecology. This ocean pipeline system solved the common problem that inland dam catchments received low rainfall while much of the coastal rain flowed out to the sea. It suddenly became possible to capture coastal rain, and people had more than enough free water than they could ever use. Water restrictions became a thing of the past. As a famous man once said, the thirsty could now have water without price from the fountains of the water of life.

A big driver of economic impact was construction built on top of the dams. The concrete barrier rose and fell with the ocean swell, but there was little up and down movement of the dam itself except with the tide. As a result, the top of the dam could be used as a stable foundation for construction of airports, factories, farms, housing, seaports, offices and sewerage works. Ocean dams therefore provided a solution for the longstanding problem of finding suitable sites for new airports. Building new airports on ocean dams proved a great way to move aircraft noise away from populated areas and release valuable city land. The new Sydney and Brisbane airport dams in Australia collected water from heavy coastal rains which had previously flowed uselessly out to sea. Fresh water was also used to provide the buoyancy for the undersea road and train links between the new airport dams and the mainland.

Shallow auxiliary dams were developed for purposes such as irrigated agricultural production, CO_2 and methane capture, urban and industrial construction and sewage treatment. The main dams tended to be very deep, up to four kilometers, but dams as shallow as twenty metres, known as lily pads, were used to grow biofuel and other crops, with a layer of soil on top about one metre deep. The weight of the soil on the water provided enough pressure for natural irrigation of the crops via standpipes distributed through the fields tapping the reservoir.

Rivers such as the Amazon and the Yangtze sent vast quantities of silt out to sea. Pipelines took dirty water from these rivers into ocean based water treatment works, big operations which divided the raw water into products including drinking water, dam water and soil for the lily pad agricultural dams. The main method of separating out the raw river water involved a series of internal barriers inside the production dam, forcing the dirty water down to the bottom on similar principle to a septic tank. Heavy silt settled and could be separated and pumped away for use, while cleaner water rose to the surface on the other side of the internal wall. Solids were pumped to the water surface from a sink hole at the base of the dam section. A series of these baffles, with surface reed beds in between them, easily produced large volumes of pure water. This method also worked for sewage treatment. Previous wasteful practices of dumping sewage into the ocean were now seen as throwing away a valuable commodity.

There was big need for more silt to grow crops on the giant lily pads to accelerate carbon capture. Carbon in the atmosphere was still over 400 parts per million, and the plan was to reduce it back to the historic norm of 280 ppm within fifty years. By 2040, lily pad dimensions were approaching thousands of square kilometers, mainly located in the stable areas at the centre of the big oceans. These shallow dams were designed to suck out the carbon which had been put in to the atmosphere during the fossil fuel era. Crops such as elephant grass, canola, sugar cane and oil palm were grown for climate-neutral sources of energy and material, and to make carbon to sequester in the deep ocean trenches. There was concern that these big dams would affect ocean ecology, but the interesting result was that the resources they provided enabled much more scrutiny and control of fishing on the high seas, to the fishes' great benefit, and by capturing the sunlight they slowed the rise in ocean temperatures. Fish could quite easily swim around these new objects, which in reality were relatively small compared to the immensity of the oceans. They also served as wildlife sanctuaries, providing secure habitat for previously endangered animals.

The really big climate impact came from biofuel for sequestration. By pumping carbon into the deep ocean trenches for storage, up to ten kilometres below the surface, the carbon dioxide level in the atmosphere was returning to normal. Instead of the sunlight going into the ocean and heating it up, vast quantities of energy were now being stored through the biofuel farms. And the fact that ocean based agriculture was entirely controlled and scientific made it more competitive than most land based farms, many of which were now reverting to forest.

New innovations were continually emerging. Use of wave energy for power generation and to reduce the impact of ocean weather on the structure was a major area of research. Systems to store rainwater from directly above and nearby were developed, including through use of attached rainwater collection ships. These ships had collector plates up to many times their own size, and moved around to capture water from rain storms and transmit this captured water to the ocean dam through flexible umbilical type pipelines built into their hulls. In some high rainfall ocean locations, rainwater was collected through buoys fixed in place above a small ocean dam. These buoys pumped water to big dams when they passed nearby on the ocean current.

The use of wave energy for propulsion, pumping and other mechanical uses was another big associated technology. Wave wings had first been introduced to power the transport of fresh water in bags through the ocean. These wings were initially used as a propulsion apparatus attached to each side of an ocean-going vessel, with propellers and drive shaft axles driven by natural energy of ocean waves. The energy of the waves was transmitted to the axles through tapered floating platforms known as wave wings, which rose and fell with the swell. They were first designed as auxiliary propulsions system for large cylindrical fabric bags of fresh water towed behind tugboats, and were mounted by fixed struts on both sides of each waterbag. Each wing was connected to an axle running the entire length of the vessel. The axle was a solid metal rod running alongside the vessel and joining together the wings. It could spin freely within the axle housings within each wing, with momentum maintained by flywheels. The wave wings were designed so the swell would make the wing move up and down at its tip, while the other end was fixed to the axle housing. Up or down movement of the wing engaged gears to force circular motion of the axle, while movement in the other direction disengaged the gears to allow the axle to keep spinning. A propeller was mounted at the end of the axle, converting the spinning energy imparted by the ocean wave through the wings and axle into forward or backward propulsion of the vessel. This innovation had a range of uses, with spinning energy of the axle providing motor energy for propulsion, electricity generation, pumping water, producing and compressing biofuel, and powering factory mechanisms.