



Introduction

This newsletter follows the format of recent years with a collection of items from various sources of potential interest to ESR members.

The last item is added purely out of personal interest. It refers to a new way of thinking about the universe.

For the first time the newsletter includes some global energy news items as suggested by our new President Jeff Foley. He is keen to see some changes to the newsletter and these are likely to become evident in future editions.

Jack Woodward

We were very sorry to hear of the death of Professor Jack Woodward, a founder member of ESR, on 23 March. Jack Woodward's accomplishments and personal qualities will be well known to many of you. Jeff Foley is preparing a tribute to Jack Woodward which will be sent to all ESR members.

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1. ESR 2023 AGM

This year's AGM was held on 15 March. The 2023 committee elected at the AGM is:

President: Jeff Foley

Secretary: Brendan Donnell

Treasurer: Thomas Neitzert

Committee Members: Lawrence Carter, Hugh MacMurray, Peter Whitmore, Douglas Wilson, Ross Rutherford, Norm Stannard, Neil Mander.

Thomas Neitzert and Ross Rutherford were promoted to Life Members. The AGM was followed by a presentation by Jill Cooper on 'Green Steel' which was well received.

2. Global Energy News

Source: Energy Sources & Distribution Magazine, Mar/Apr 2023

China's largest standalone energy storage system with a Lithium LFP battery has gone live. The 200MW/400MWh storage station in Ningxia has been connected to the grid, storing the energy generated by renewable sources such as solar and wind. The project can provide electricity for 300 households for one year consumption.

An FRV Australia and Genesis JV has acquired a 93ha large-scale solar site about an hour's drive from Christchurch. The proposed Lauriston Solar Farm will power the equivalent of 9,800 houses.

Sinopec has launched the world's largest green hydrogen-coal demonstration project in Inner Mongolia. The project will utilise the rich solar and wind energy resources in the Erdos region to produce green hydrogen directly, projecting to reach an annual capacity of 30,000 tonnes of green hydrogen and 240,000 tonnes of green oxygen, which will be used for the carbon reduction initiatives of the adjoining ZTHC Energy intensive coal processing pilot project in Erdos.

St Georges Eco-Mining Corp subsidiary H2SX and Altima Resources Ltd have entered into an agreement to move forward with the production of cheap and green hydrogen in Canada. Altima intends using H2SX's hydrogen production and nano-carbon technology for the conversion of natural gas originating from gas and condensate wells in Alberta and British Columbia.

3. First electric car with sodium-ion battery

Extracts from an article by Daniel Zlatev, Published 02/24/2023 E-Mobility

Volkswagen's joint venture with JAC in China has produced the first electric car powered by the nascent sodium-ion battery technology. Provided by HiNa Battery, the mass-produced pack is installed in one of the joint venture Sehol brand's models - the E10X - which is a

small urban electric car with a very affordable price and decent range that VW sells boatloads of in China.

With the sodium-ion battery, the test Sehol E10X is able to cover about 157 miles (252km) on a charge and is capable of charging at up to 4C speeds or 15 minutes. The Na-ion cells of HiNa Battery currently ship with energy density of 145 Wh/kg and are rated for 4,500 full charge-discharge cycles. Doubling of the cycles and 200 Wh/kg energy density is expected for the second Na-ion battery generation that HiNa is currently developing.

While those numbers don't sound all that impressive compared to the density of current performance lithium batteries, Na-ion cells are much more affordable to produce and with chemistry that is way less volatile. Tesla's much touted 4680 cells in the Model Y, for instance, have adjusted energy density of 244 Wh/kg, so the difference with the second sodium-ion battery generation won't be that big.

The world's biggest EV battery makers CATL and BYD are also on the cusp of mass Na-ion battery production, with BYD in particular expected to start this year.

4. Why Roman buildings have survived so long

From an article by Katie Hunt, CNN, updated 9 January 2023

The majestic structures of ancient Rome have survived for millennia — a testament to the ingenuity of Roman engineers, who perfected the use of concrete. But how did their construction materials help keep colossal buildings like the Pantheon (which has the world's largest unreinforced dome) and the Colosseum standing for more than 2,000 years?

Roman concrete, in many cases, has proven to be longer-lasting than its modern equivalent, which can deteriorate within decades. Now, scientists behind a new study say they have uncovered the mystery ingredient that allowed the Romans to make their construction material so durable and build elaborate structures in challenging places such as docks, sewers and earthquake zones.

The study team, including researchers from the United States, Italy and Switzerland, analyzed 2,000-year-old concrete samples that were taken from a city wall at the archaeological site of Privernum, in central Italy, and are similar in composition to other concrete found throughout the Roman Empire.

They found that white chunks in the concrete, referred to as lime clasts, gave the concrete the ability to heal cracks that formed over time. The white chunks previously had been overlooked as evidence of sloppy mixing or poor-quality raw material. "For me, it was really difficult to believe that ancient Roman (engineers) would not do a good job because they really made careful effort when choosing and processing materials," said study author Admir Masic, an associate professor of civil and environmental engineering at the Massachusetts Institute of Technology.

"Scholars wrote down precise recipes and imposed them on construction sites (across the Roman Empire)," Masic added.

The new finding could help make manufacturing today's concrete more sustainable, potentially shaking up society as the Romans once did.

"Concrete allowed the Romans to have an architectural revolution," Masic said. "Romans were able to create and turn the cities into something that is extraordinary and beautiful to live in. And that revolution basically changed completely the way humans live."

Lime clasts and concrete's durability

Concrete is essentially artificial stone or rock, formed by mixing cement, a binding agent typically made from limestone, water, fine aggregate (sand or finely crushed rock), and coarse aggregate (gravel or crushed rock).

Roman texts had suggested the use of slaked lime (when lime is first combined with water before being mixed) in the binding agent, and that's why scholars had assumed that this was how Roman concrete was made, Masic said. With further study, the researchers concluded that lime clasts arose because of the use of quicklime (calcium oxide) — the most reactive, and dangerous, dry form of limestone — when mixing the concrete, rather than or in addition to slaked lime.

Additional analysis of the concrete showed that the lime clasts formed at extreme temperatures expected from the use of quicklime, and "hot mixing" was key to the concrete's durable nature. "The benefits of hot mixing are twofold," Masic said in a news release. "First, when the overall concrete is heated to high temperatures, it allows chemistries that are not possible if you only used slaked lime, producing high-temperature-associated compounds that would not otherwise form. Second, this increased temperature significantly reduces curing and setting times since all the reactions are accelerated, allowing for much faster construction."

To investigate whether the lime clasts were responsible for Roman concrete's apparent ability to repair itself, the team conducted an experiment. They made two samples of concrete, one following Roman formulations and the other made to modern standards, and deliberately cracked them. After two weeks, water could not flow through the concrete made with a Roman recipe, whereas it passed right through the chunk of concrete made without quicklime.

Their findings suggest that the lime clasts can dissolve into cracks and recrystallize after exposure to water, healing cracks created by weathering before they spread. The researchers said this self-healing potential could pave the way to producing more long-lasting, and thus more sustainable, modern concrete. Such a move would reduce concrete's carbon footprint, which accounts for up to 8% of global greenhouse gas emissions, according to the study.

For many years, researchers had thought that volcanic ash from the area of Pozzuoli, on the Bay of Naples, was what made Roman concrete so strong. This kind of ash was

transported across the vast Roman empire to be used in construction, and was described as a key ingredient for concrete in accounts by architects and historians at the time. Masic said that both components are important, but lime was overlooked in the past.

The research was published in the journal *Science Advances*.

5. Study finds climate crisis worsened extreme weather

Extracts from an article in the Guardian website, Oliver Milman in New York, 9 Jan 2023

Relentless drought in California, extreme rainfall in the UK, record heat in China – some of the most severe weather events that have occurred around the world in the past few years were made far more likely due to the climate crisis, new research has found. The analysis of extreme events in 2021 and 2022 found that many of these extremes were worsened by global heating, and in some cases would have been almost impossible in terms of their severity if humans had not altered the climate through the burning of fossil fuels.

The fingerprint of climate change is being identified across the planet. The risk of extreme drought across California and Nevada was made six times worse by the climate crisis and a strong periodical La Niña climate event from October 2020 to September 2021, while, conversely, extreme rainfall that deluged parts of the UK in May 2021 was 1.5 times more likely due to global heating.

A severe hot spell in China in February 2021 was made between four and 20 times more likely because of human-caused climate change, while acute drought in Iran, which it experienced in 2021, is now 50% more likely because of the greenhouse gases humanity has pumped into the atmosphere.

A swath of other severe impacts can be attributed, at least in part, to the influence of the climate crisis, including the weather that caused a dangerous wildfire in Cape Town, South Africa, in 2021 to be 90% more likely than if we had never heated up the planet and even the persistent cloudiness over the Tibetan plateau that reduced vegetation growth, caused, researchers say, by elevated global temperatures along with abnormal winds and localized pollution.

The compendium of research, presented by Noaa at a conference in January 2023, draws together some of the latest examples of climate attribution, where scientists have managed to pinpoint the influence of human-induced climate change upon individual weather events and disasters. Using increasingly powerful climate models, along with historical observations, scientists are now able to provide more a precise, and rapid, assessment of the influence of the climate crisis on certain disasters. The heavy rain that caused devastating floods in Nigeria, Niger and Chad last year, for example, was made about 80 times more likely by the climate crisis, one study has found.

Many of the temperatures now being seen are well beyond any modern historical norms and are pushing humanity into a new, dangerous state. A heatwave in South Korea in

October 2021, for example, was so drastic, at almost 7F higher than normal, that it would be considered an event that would only happen every 6,250 years. But the climate models predict that this will become the new normal for South Korea by 2060 if planet-heating gases are not radically cut. The same fate may well await the normally temperature Pacific north-west of the US, where around 600 people died as a roasting heatwave pummeled the region in 2021. A subsequent study found the climate crisis made the heatwave 43 times more likely.

“Human-caused climate change is an extreme disruption of the Earth system,” said Paul Higgins, associate executive director of the American Meteorological Society. “We should expect it to lead to more extreme events, as this new research helps to show. We must do what we can to help people, and all life, thrive in spite of this danger.”

6. Eight ways to attempt to stay within 1.5°C increase

*Extracts from an article by **Fiona Harvey** Environment editor, Guardian, 21 Mar 2023*

The Intergovernmental Panel on Climate Change published the “synthesis report” of its sixth assessment report (AR6) on Monday. Eight years in preparation, this mammoth report encompasses the entire range of human knowledge of the climate system, compiled by hundreds of scientists from thousands of academic papers, and published in four parts, in August 2021, February and April 2022, and March 2023.

The report drew together the most important findings – but also highlighted some key measures that governments and countries must take immediately if we are to avoid climate catastrophe:

Reduce methane

Sharp cuts to short-lived climate pollutants, methane chief among them, could cut more than half a degree from global heating. Produced from oil and gas operations and coalmines, and from animal husbandry and natural sources – such as decaying vegetation – methane is a greenhouse gas about 80 times more powerful than carbon dioxide. But it lasts only for about 20 years before degrading into CO₂.

Durwood Zaelke, a peer review scientist for the IPCC’s AR6 report, and founder of the Institute for Governance and Sustainable Development in the US, says cutting it is “the best way to slow near-term warming – indeed the only way we know of, short of [geoengineering through] solar radiation management, carbon dioxide removal and methane removal, all of which are still speculative”.

Cutting it should be easy: the International Energy Agency found that plugging the leaks from fossil fuel operations was not only low-cost but in most cases actively profitable. But many of these operations are in countries with little interest in climate action – Russia is the worst offender, but even in the US, action has been feeble – and despite the Methane

Pledge signed by close to 100 countries since 2021, methane emissions continue to rise strongly.

Stop deforestation

Cutting down rainforests destroys some of the world's biggest carbon sinks and risks taking the world to a "tipping point" at which vast forests such as the Amazon and the Congo become sources of carbon dioxide to the atmosphere instead of absorbing it.

The world's remaining forests are also vital hotspots for biodiversity, so preserving them not only keeps the lungs of our planet alive but is essential to any hope of stemming the catastrophic loss of global species, as well as for Indigenous people who live there.

There is hope that the recent disastrous rates of deforestation seen in Brazil will abate under the return of President Lula, but the work will be difficult. The Congo is also still under severe threat, and despite progress in Malaysia and Indonesia the destruction of forests there for palm oil continues.

Restore other degraded land, and stop it being turned to agriculture

Forests grab the headlines, but many other aspects of natural ecosystems are vital absorbers of carbon, yet are being degraded. Restoring them would benefit nature and the climate. Wetlands and peatlands store vast quantities of carbon, but are under threat as they are drained for agriculture. In the oceans, mangrove swamps and seagrass meadows – which store carbon and can help to reduce the impacts of rising sea levels and storms – have been destroyed.

The oceans themselves are huge carbon sinks, but their capacity to absorb and store carbon is increasingly under threat at higher temperatures. Stopping overfishing, for instance by cutting wasteful subsidies for industrial fishing, and allowing natural marine ecosystems to regenerate would restore some of the natural carbon cycle of the oceans.

Change agriculture, and change the way we eat

Feeding the world's future population using current food systems will be impossible, but shifting to a more sustainable diet that is rich in plants and short on meat and dairy products would go a long way.

Beyond meat-eating, fertilisers release nitrous oxide, a strong greenhouse gas in its own right. Fortunately, modern agricultural methods, using precision farming techniques can offer a way of keeping yields high while reducing the impact on the climate and nature.

Finally, reducing food waste will be vital, as globally one-third of all food produced for human consumption is wasted. In poor countries in the global south, the lack of refrigeration is also a key factor in wasting food before it can be consumed, and is worth investment.

Solar and wind power

Renewable energy in the form of wind and solar power is now cheaper than fossil fuels across most of the world and the IPCC found that solar power, wind power and reducing the conversion of land to agriculture were the three measures with the strongest potential for reducing greenhouse gas emissions globally.

The US and the EU are now engaged in a renewable energy arms race, which is likely to spur competition further. China is the one to watch, however, adding almost as much renewable energy to the grid last year as the rest of the world combined. China also has a near-monopoly on some critical minerals used in clean technology, a position in which the US and the EU are belatedly taking interest.

Energy efficiency

The International Energy Agency found that using energy more efficiently was the single largest potential contributor to reaching net zero greenhouse gas emissions. But between 2015 and 2020 improvement in global primary energy intensity slowed, averaging 1.4% a year, down from 2.1% a year over the period 2010-2015. Despite initial signs of a recovery, weak global energy intensity improvements of below 1% a year were observed in 2020 and 2021, as Covid-19 lockdowns bit. This was well below the 4% a year required on average from 2020 to 2030, the IEA warned.

Transport is also ripe for change. More efficient public transport systems around the world would benefit people, boost the economy, reduce air pollution and cut greenhouse gas emissions, but in too many urban centres this is an area severely neglected by governments.

Stop burning coal

Switching from coal to gas-fired power would reduce greenhouse gas emissions globally by more than making all buildings energy efficient. But many governments – including China, which recently approved the biggest expansion of coal-fired power plants since 2015, as well as India and Australia – are deeply entwined with coal interests, and have seen coal as essential to national energy security.

But it can be done. In developing countries, just energy transition partnerships have begun in South Africa, Vietnam and Indonesia to help workers to move out of coal and into highly skilled jobs in renewable energy generation.

Put climate at the heart of all decision-making

Historically environment ministries have been on the periphery of government, subservient to finance and business ministries.

This is no longer tenable. The IPCC issued a plea on Monday for the climate to be at the heart of all government policy, and all decision-making in business.

Only by “mainstreaming” climate action, in the unlovely UN jargon, into the decisions of all government departments, and at board level in business, can we hope to make the many changes needed.

The good news is that everybody should benefit, from better health and wellbeing, green jobs and a more vibrant economy, and by reducing the threat of climate catastrophe. Dr Hoesung Lee, the chair of the IPCC, said: “Mainstreaming effective and equitable climate action will not only reduce losses and damages for nature and people, it will also provide wider benefits. This synthesis report underscores the urgency of taking more ambitious action and shows that, if we act now, we can still secure a liveable sustainable future for all.”

7. Global fresh water demand to outstrip supply by 40% by 2030

*Extracts from an article by **Fiona Harvey** Environment editor Guardian 17 Mar 2023*

The world is facing an imminent water crisis, with demand expected to outstrip the supply of fresh water by 40% by the end of this decade, experts have said on the eve of a crucial UN water summit. Governments must urgently stop subsidising the extraction and overuse of water through misdirected agricultural subsidies, and industries from mining to manufacturing must be made to overhaul their wasteful practices, according to a landmark report on the economics of water.

Nations must start to manage water as a global common good, because most countries are highly dependent on their neighbours for water supplies, and overuse, pollution and the climate crisis threaten water supplies globally, the report’s authors say.

Johan Rockstrom, the director of the Potsdam Institute for Climate Impact Research and co-chair of the Global Commission on the Economics of Water, and a lead author of the report, told the Guardian the world’s neglect of water resources was leading to disaster. “The scientific evidence is that we have a water crisis. We are misusing water, polluting water, and changing the whole global hydrological cycle, through what we are doing to the climate. It’s a triple crisis.”

Many governments still do not realise how interdependent they are when it comes to water, according to Rockstrom. Most countries depend for about half of their water supply on the evaporation of water from neighbouring countries – known as “green” water because it is held in soils and delivered from transpiration in forests and other ecosystems, when plants take up water from the soil and release vapour into the air from their leaves.

More than \$700bn of subsidies globally go to agriculture and water each year and these often fuel excessive water consumption. Water leakage must also be urgently addressed, the report found, and restoring freshwater systems such as wetlands should be another priority.

Water is fundamental to the climate crisis and the global food crisis. “There will be no agricultural revolution unless we fix water,” said Rockstrom. “Behind all these challenges we are facing, there’s always water, and we never talk about water.”

Seven calls to action on water

1. Manage the global water cycle as a global common good, to be protected collectively and in our shared interests.
2. Ensure safe and adequate water for every vulnerable group, and work with industry to scale up investment in water.
3. Stop underpricing water. Proper pricing and targeted support for the poor will enable water to be used more efficiently, more equitably, and more sustainably
4. Reduce the more than \$700bn of subsidies in agriculture and water each year, which often fuel excessive water consumption, and reduce leakage in water systems.
5. Establish “just water partnerships” which can mobilise finance for low- and middle-income countries.
6. Take urgent action this decade on issues such as restoring wetlands and depleted groundwater resources; recycling the water used in industry; moving to precision agriculture that uses water more efficiently; and having companies report on their “water footprint”.
7. Reform the governance of water at an international level, and including water in trade agreements. Governance must also take into account women, farmers, indigenous people and others in the frontline of water conservation.

8. Pollution leaves New Zealand wetlands badly damaged

From an article by Tess McClure in Whangamarino, @tessairini 24 Mar 2023

As David Klee nosed his boat out into the channels of Whangamarino, he saw the birds were dying. Hundreds were already dead, floating, the sheen of their feathers dulling in the scum near the banks of the river. Others, he could tell, would be dead soon: flocks that should have been sent flapping in alarm by the boat’s passage sat placid, unmoving in the water. Often, the bird’s legs go first, says Klee, the local game bird manager for Fish & Game New Zealand. Instead of paddling, they start scooping their wings through the water to propel themselves forward, a grotesque butterfly stroke. The poison works on the extremities, attacking nerves that thread down the limbs and wingspan. Then, the muscles of the neck weaken and seize: unable to hold the weight of the head, they droop forward, slip underwater, and the birds drown.

The birds of Whangamarino, a freshwater wetland covering 7,000 hectares in Waikato, in New Zealand’s North Island, are being killed by a botulism outbreak, a consequence of mass fish deaths, which in turn are prompted by flooding, algal blooms and high levels of pollutants including heavy nutrient load from farming. This summer, the birds died in their thousands: swans, ducks, geese, spoonbills. As the season drew to a close, teams of

volunteers fished the feathered bodies from the water and piled them hundreds-high in boats and pickup trucks.

The Waikato region is considered the dairy powerhouse of New Zealand, producing more than 25% of the country's milk supply. That industry has been long connected to high levels of nitrogen in waterways – runoff from the fertiliser used to cultivate year-round grass, and the effluent of the cows that graze it.

As New Zealand struggles to make meaningful improvements to its polluted waterways, ecologists say some bodies of water in the region are reaching – or may have already passed – tipping points from which they may never bounce back. “We’re living it now,” says Fish & Game’s chief executive, Corina Jordan. “These systems are really resilient. But what we’ve done is we’ve overloaded them to the point where they are finding it really difficult to recover.” The losses have left community, tribal and environmental groups furious, and grieving for the waterways that formed a crucial part of their communities for generations.

Ngāti Naho are mana whenua (a tribal group with customary rights to the area), and this summer Solomon spent days out on the water, pulling dead birds from the swamp. “You feel like you’re in a horror movie,” he says. “To see that – to see any creature, any living being drown itself – it’s not a pleasant sight to see. You’ve got all these floating carcasses around you and you can’t see the bottom. The water, it’s almost pitch black.”

The summer botulism outbreak came in the wake of mass die-offs of fish a few weeks earlier, Klee says, after flooding had sent heavily polluted water channelling through to the wetlands. Just before Christmas, monitoring had shown a “black water event” – where higher temperatures, heavy rainfall and excess levels of nutrients or algal blooms remove oxygen from the water. “Parts of this wetland and some of the rivers leading into it were without oxygen for the best part of three months – they literally flatlined,” Klee says. Botulism, the toxin that kills the birds, requires high levels of protein to survive, and the mass fish deaths provide an ideal environment. “Basically three to four weeks later – you can almost set your clock by it – you get a botulism outbreak”.

For Māori, these waterways and wetlands were a source not only of food, weaving materials and medicine but of “strong spiritual sustenance”, he says. Now, in parts of the Waikato, that water has turned to poison. Up the road from the wetland, on the shores of Lake Waikare, a formal warning has been erected. “This lake water may be unsafe to touch,” it reads. “Avoid any activity which involves skin contact with the water.” Locals call it “Lake Fanta”, for the toxic algal blooms that often turn the surface a bright, lurid shade of orange.

Waikare is ranked as one of the most polluted lakes in the world, and its waters channelled into wetlands including Whangamarino every time there was a storm. “The lake is really saturated with plant nutrients like phosphorus and nitrogen,” says Associate Prof Deniz Özkundakci, a freshwater ecologist at the University of Waikato. It is not only farming runoff seeping into the lake – human wastewater has been released into it for decades, and from 2019, Waikato district council allowed non-compliant wastewater – laced with E.coli, nitrogen and phosphorus – to be pumped into the water.

The lake is now so degraded that there are no clear models for bringing it back to health, Özkundakci says. “Because of the state of the lake, I don’t even know what the end state, the relevant rehabilitative state might look like.”

Lake Waikare represents one of the furthest-gone examples, but across New Zealand, the country’s waterways are under threat. About 60% are unswimmable, 74% of freshwater fish are threatened or at risk of extinction and 95% of rivers flowing through pastoral land are contaminated by pollutants, effluent or excess nutrients. The existing problems are being exacerbated by the climate crisis, which causes heavier rainfalls, more floods and higher temperatures, all of which increase chances of toxic algal blooms and mass fish deaths. “Climate change will exacerbate some of the existing problems,” says Özkundakci. “There needs [to be] some discussion around what should be done.”

Waikato district council said in a statement that it had taken action at Whangamarino, including “financial support of \$5,000 to help crews working in the wetland pick up dead birds and fish to lessen the environmental effect”, and was developing a multi-agency response to try to anticipate and reduce blackwater events.

On the shoreline of Lake Waikare, the banks are quiet and still, waves lapping grime over the *toetoe* grasses at the water’s edge. No birds fly over the water.

9. Cities looking to work with rather than against water

Sponge cities, China



Before (concrete channel)



After (landscaped)

China, which suffers from both flooding and drought, has long been an advocate of “sponge cities.” The idea is to enable cities to soak up and retain excess water with designs focused on nature, including gardens, green roofs, wetlands and permeable sidewalks – allowing water to both sink into the ground and flow outwards.

In 2015, the government announced a pilot scheme of 16 sponge cities, prompted in part by severe flooding which hit Beijing in 2012, killing nearly 80 people and causing widespread damage. Many more projects have since been added.

“All cities are trying to resist water like an enemy,” said architect and professor Kongjian Yu, founder of design firm Turenscape and the pioneer of sponge cities. The aim of sponge cities is to “give water more space,” he told CNN.

Yongxing River Park in Beijing is one of Yu’s many sponge city projects. Formerly a concrete drainage channel, Turenscape turned it into a “sponge river,” designed to manage floodwaters and filter rainwater. A network of paths connects the park, which is full of plants and trees, including willow, crab apple and hawthorn trees. It also has playgrounds for children as well as a sports ground.

As sponge cities proliferate in China, there have been some questions about their ability to cope with heavier rains and storms, made more severe by climate change. In 2021, the city of Zhengzhou, in Henan province, which is part of the sponge city initiative, experienced devastating rains that killed almost 300 people.

But for Yu, sponge cities offer a necessary correction to the mistakes that have been made as cities grow, including damaging and destroying rivers and wetlands and heavy reliance on concrete.

Copenhagen, Denmark: Building a giant ‘climate park’



Enghaveparken, a "climate park" in Copenhagen

In 2011, Copenhagen experienced a cloudburst – a very sudden and destructive rainstorm which unleashed months’ worth of rain over a few hours, leaving parts of the city under a meter of water. Damages were extensive, estimated at around \$1 billion. The disaster supercharged the city’s climate plans. One of its responses is Enghaveparken – a huge “climate park.”

The park, which dates back to 1928, was redesigned by architectural firm Tredje Natur (Third Nature). “It was kind of a catch 22 situation,” Fleming Rafn, a founding partner of Tredje Natur, told CNN. They had to work out how to preserve the park’s heritage, while preparing it for a future of more extreme climate events. The redesigned park, which lies at the bottom of a hill, is based on the idea of having chambers for water.

A concrete hockey court was lowered 3 meters, and will be the starting point for containing flood water. After the court fills up, water can flow on to a sunken rose garden and finally to the lake. The park also has subterranean basins, which harvest rainwater from the neighbourhood.

A perimeter wall around the park will keep water contained and was built in a way that meant all the historical trees could remain where they were, Rafn said. In extreme 100-year events, the whole 35,000 square meters of park can be filled with water from end to end, where it can be contained until floods have eased enough for the water to be released into the sewer system. The park can handle around 6 million gallons.

The aim is to reconnect people with nature and the impacts of the climate crisis, Rafn said. "It's so difficult for us to understand climate and our own relationship with it, and how do we as individuals actually participate in something that is this abstract, and I think making it tangible has a large promise in terms of making it more of a down-to-Earth discussion."

Amsterdam, the Netherlands: Turning homes into boats

The Netherlands, around a third of which lies below sea level, is trying to work with the water by literally building on it. In the northern Amsterdam neighborhood of Schoonschip, architecture firm Space&Matter has designed a community of 30 houses on the water. Construction was completed in 2021 and it's now home to more than 100 residents.

Built with timber frames and insulated with burlap and straw, the homes are equipped with heat pumps and solar panels. Roof gardens aim to help them cool in the summer as well as absorbing rainwater. A flexible jetty connects the houses with each other and to the land. They are designed to rise and fall with the ebb and flow of the water.

10. Peak human population may not exceed 8.8 billion

From an article by Jonathan Watts, @jonathanwatts, guardian website, 27 Mar 2023

The long-feared "population bomb" may not go off, according to the authors of a new report that estimates that human numbers will peak lower and sooner than previously forecast. The study, commissioned by the Club of Rome, projects that on current trends the world population will reach a high of 8.8 billion before the middle of the century, then decline rapidly. The peak could come earlier still if governments take progressive steps to raise average incomes and education levels.

The new forecasts are good news for the global environment. Once the demographic bulge is overcome, pressure on nature and the climate should start to ease, along with associated social and political tensions. But the authors caution that falling birthrates alone will not solve the planet's environmental problems, which are already serious at the 8 billion level and are primarily caused by the excess consumption of a wealthy minority.

Previous studies have painted a grimmer picture. Last year, the UN estimated the world population would hit 9.7 billion by the middle of the century and continue to rise for several decades afterwards. The new projection was carried out by the Earth4All collective of leading environmental science and economic institutions, including the Potsdam Institute for Climate Impact Research, Stockholm Resilience Centre and the BI Norwegian Business School. They were commissioned by the Club of Rome for a follow up to its seminal Limits to Growth study more than 50 years ago.

The report is based on a new methodology which incorporates social and economic factors that have a proven impact on birth rate, such as raising education levels, particularly for women, and improving income.

11. The Origin of Time?

Extracts from an article by Robin McKie Science Editor, Observer, 19 Mar 2023

In 2002 Thomas Hertog received an email summoning him to the office of his mentor Stephen Hawking. The young researcher rushed to Hawking's room at Cambridge. "His eyes were radiant with excitement," Hertog recalls. Typing on the computer-controlled voice system that allowed the cosmologist to communicate, Hawking announced: "I have changed my mind. My book, *A Brief History of Time*, is written from the wrong perspective."

In April 2023, five years after Hawking's death, the book – *On the Origin of Time: Stephen Hawking's final theory* – will be published in the UK. "The problem for Hawking was his struggle to understand how the universe could have created conditions so perfectly hospitable to life," says Hertog, a cosmologist currently based at KU Leuven University in Belgium.

Examples of these life-supporting conditions include the delicate balance that exists between particle forces that allow chemistry and complex molecules to exist. In addition, the fact there are only three dimensions of space permits stable solar systems to evolve and provide homes for living creatures. Without these properties, the universe would probably not have produced life as we know it, it is argued by some cosmologists.

"Stephen told me he now thought he had been wrong and so he and I worked, shoulder to shoulder, for the next 20 years to develop a new theory of the cosmos, one that could better account for the emergence of life," Hertog said. It was out of these "conversations" (between Hertog and Hawking) that Hawking's final theory was born and, in conjunction with Hertog's own analysis, they form the basis of *On the Origin of Time*, a book that takes its title from Charles Darwin's *On the Origin of Species*. "In the end, we both came to think of physics in a way much more like how we think of biology. We have put physics and biology on the same footing."

According to Hertog, *On the Origin of Time* deals with questions about our place in the universe and what makes our universe fit for life. "These questions were always in the background in our scientific publications." "Stephen and I discovered how physics itself can

disappear back into the big bang. Not the laws as such but their capacity to change has the final word in our theory. This sheds a new light on what cosmology is ultimately about.”

According to Hertog, the new perspective that he has achieved with Hawking reverses the hierarchy between laws and reality in physics and is “profoundly Darwinian” in spirit. “It leads to a new philosophy of physics that rejects the idea that the universe is a machine governed by unconditional laws with a prior existence, and replaces it with a view of the universe as a kind of self-organising entity in which all sorts of emergent patterns appear, the most general of which we call the laws of physics.”

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