**Hello and welcome to Just Have Another think, our monthly look at the ecological, environmental and social consequences of our twenty first century climate emergency.**

**About the middle of September each year, as the northern hemisphere Summer season draws to a close, the Arctic Sea reaches a point of minimum sea ice cover. As many of you no doubt already know, the extent of that annual minimum has been declining ever since satellite records began back in the late nineteen seventies, and in twenty twelve the region experienced a record low extent of three point four one million square kilometres, leading some commentators to suggest we might see an ice free summer arctic by 2020. Thankfully, that didn’t happen, and in fact the annual minimums have fluctuated a little bit since then. This year’s minimum was actually only the twelfth lowest on record, although it was still well below the levels seen in the nineteen eighties. There were some quite well documented and fairly specific weather events causing this year’s somewhat unusually high minimum, which are unlikely to combine together in the same way next year, so the trajectory of the travel is very likely to continue inexorably towards zero over the coming years.**

**Our seas and oceans cover seventy one percent of the Earth’s surface and they’re responsible for regulating our planet’s climate and sustaining all life. They’ve already absorbed about a third of all the carbon dioxide we’ve emitted since the industrial revolution and about ninety percent of the earth’s extra heat since the mid twentieth century. Our human activity and over exploitation of ocean resources is turbocharging natural variation, causing unprecedented changes in the composition of the water itself, the ecosystems within it and the coastlines that surround it.**

**In September 2021, the Copernicus Marine service published the latest of their annual reports using a set of parameters called Ocean Monitoring Indicators to describe, measure, and monitor the state of the ocean, observing all the relevant phenomena causing the changes. Those phenomena are grouped into three categories. The first of which they call The Blue Ocean, the physical state of the ocean, including things like sea surface temperature, sea level, ocean currents, waves, and sea winds as well as ocean heat content, salinity and density.**

**This year’s analysis shows that sea surface temperatures in all parts of the global oceans increased by an average of point zero one five degrees Celsius every year between nineteen ninety-three and twenty nineteen. That might not sound like a lot on an annual basis, but it adds up to an increase of point four degrees Celsius over just twenty-six years, with the surface of the Baltic and Mediterranean warming by almost a full degree Celsius over that time period. Global sea levels have been rising by just over three millimetres per year, or about eight centimetres since nineteen ninety-three. And the rate of rise is accelerating. Again, the Baltic Sea has seen the biggest rise, at almost twelve centimetres.**

**The overall heat content of the oceans is measured in watts per square metre, just in the same way that we measure the energy from sunlight hitting our planet each day. To maintain stable planetary systems, there should be more or less no increase in land or sea surface temperature. In other words, the heat energy reaching our planet should be balanced by the heat energy escaping our planet each day. That’s pretty much the way things were from the end of the last glacial period about ten thousand years ago, right up to the beginning of the industrial revolution. There are some small variations in the solar irradiance reaching us, as a result of orbital fluctuations and solar activity. People much smarter than me have calculated the range of those changes as being between zero point zero five and zero point one five watts per square metre. But this analysis shows that just in the fourteen years between two thousand and five and twenty nineteen the heat content of the oceans, from the surface right down to a depth of two thousand metres, has increased by one watt per square metre, which across an expanse of water as vast as that, is an absolutely mind-blowing amount of energy.**

**Why is all that important? Well, the report explains that sea surface temperature plays a vital role in regulating the earth’s climate and atmosphere, and in influencing the evolution of severe weather events.**

**Ocean warming contributes about thirty to forty percent to global mean sea level rises, worsening the already catastrophic flooding happening in low lying areas, damaging coastal infrastructure and disrupting coastal marine environments. Warmer waters alter ocean currents and reduces the solubility of carbon dioxide in the water, which means more CO2 stays in the atmosphere instead. The extra heat also causes stratification, or temperature layering, at different depths, making it much more difficult for nutrients to rise up from the deep waters to feed phytoplankton and other fundamental elements in the ocean food chain, which brings us to the second Ocean Monitoring Indicator - the Green Ocean. This indicator refers to the biological and biochemical state of the ocean, including chlorophyll and nutrient concentrations as well as ocean acidification and deoxygenation.**

**Ocean Acidification is the one that always seems to grab the headlines, and we had a close look at it in one of the very first videos on this channel, which you can jump back to by clicking the link up there. Essentially, the ecosystems in the oceans are extremely sensitive to quite small changes in the pH levels of the water. Between nineteen eighty-five and twenty nineteen, average pH levels have reduced by zero point zero six. Again, that sounds tiny as a number, but on the pH scale it represents a thirty percent increase in acidity, posing a severe threat to marine life, and especially to corals and shellfish that increasingly struggle to find calcium carbonate for their structures.**

**Roughly half of Earth’s oxygen production also takes place in the oceans. As we humans continue to accelerate climate change and release excessive nutrients into the water from agricultural and chemical run-off – a process known as Eutrophication, we’re contributing to dangerous levels of deoxygenation, threatening marine life cycles all the way from the seashore right down to the greatest ocean depths.**

**Then there’s the white ocean, which as the name suggests, refers to the lifecycle of floating ice within the polar regions.**

**The study shows that between nineteen seventy-nine and twenty-twenty, the annual average extent of sea ice in the Arctic has been reducing by more than half a million square kilometres per decade, with an even more dramatic decrease of more than eight hundred thousand square kilometres per decade in the Summer months – a reduction of nearly thirteen percent every ten years. And you don’t need to be Einstein to work out how that’s going to end, as this graphic representation by Andy Lee Robinson shows all too clearly. Check out the black line representing the annual September minimum. As it winds around the dial from 1979 through to 2021 you can see how it’s spiralling in towards zero, or what some climate commentators refer to as a Blue Ocean Event. The consequences of that eventuality are very severe indeed, not just for marine life but for almost every aspect of human existence on the planet. I examined the top ten worst impacts in a deep dive video a couple of years back. It doesn’t make for pleasant viewing I’m afraid, but if you want to know the details then you can click on that link to jump back and have a look.**

**And in case you were hoping that the losses in the Arctic might be compensated by gains in the Antarctic…well, no such luck I’m afraid. There has been a slight increase in the Antarctic Sea ice extent but, according to this report, it’s really not enough to be statistically relevant.**

**The impacts of a changing Ocean are now being felt in just about every corner of the planet. Rising sea levels have already engulfed some parts of the small island nations, forcing communities to continuously move from island to island or try to find a way to relocate to a mainland, something that is much easier said than done. Low lying coastal regions like those in Bangladesh will be overwhelmed in the coming years, causing mass migrations of very large populations of people. And the rich western nations won’t escape the consequences either. Venice was a high-profile example in twenty nineteen when a combination of unusually high sea level, a high spring tide, and extreme local and regional weather conditions caused an unprecedented series of exceptionally strong high waters or Acqua Alta events, as the local call them. Water levels rose by one point eight nine metres, which is more than six feet - the highest recorded level since 1966.**

**Warming ocean waters have also caused many marine species to move towards cooler waters, either going deeper in the ocean or physically migrating towards the poles. Those migrations are not only depriving regional fishermen of the fish stocks that they and their families rely on, but they’re also resulting in the introduction of non-native and invasive species to different marine ecosystems.  In 2019, increasing temperatures in the eastern Mediterranean basin resulted in an infiltration of the highly predatory lionfish into the Mediterranean Sea from the Suez Canal to the Ionian Sea, decimating local marine life that had no defences against this alien invader. And extreme temperature events like marine heatwaves are becoming more common, more severe and longer lasting, affecting the catches and populations of various marine species.**

**So, what can we do in the face of these mounting catastrophes?**

**Well, in conjunction with all these other agencies and organisations, the Copernicus Marine Service is advocating a global structure of monitoring, communication, education and governance aimed at shifting human interaction with the oceans towards much more intelligent and sustainable stewardship as the consequences of climate change continue to worsen. The foundation of the initiative is the Global Ocean Observing System, or GOOS, led by UNESCOs Intergovernmental Oceanographic Commission, co-sponsored by the World Meteorological Organization, the United Nations Environment Programme and the International Science Council. GOOS encompasses a wide range of in situ and remote sensing measurement techniques delivering essential information for the safety and well being of our ocean ecosystems. That data feeds into studies like the Copernicus Marine Service report and helps clarify and emphasise the crucial messages that need to be communicated to policymakers around the world. The goal is for that knowledge to help the big decision makers really understand the function of the ocean and take stock of the rapid changes in their health, services and vitality to develop appropriate measures of sustainable ocean stewardship.**

**Observations like Copernicus are showing that the oceans have been absorbing so much of the CO2 and heat energy that we humans have spewed out over the last couple of centuries that they’ve really been masking the true severity of our climate predicament. That can’t continue indefinitely of course, and there are already signs that the oceans are reaching the limits of what they can cope with, so initiatives like the Copernicus program will play a vital role in raising awareness and urgency in the minds of our world leaders! Let’s hope they find the wisdom to listen and act!**

**Thanks for watching, and I’ll see you soon.**