The world and its climate in the year 2200: a brief history of two centuries of a changing world

(constantly updated as a work in progress when new facts become clear)

Looking back from 2200, at the end of the most prosperous and peaceful century in mankind`s history, enables us to view clearly what went wrong and right in mankind`s epic struggle for climate stability and a planet healthy enough to nurture us.

This is no work of fiction, but of probabilities, whose range is clearly restricted by the laws of physics and psychology. If taken together they limit potential outcomes dramatically. An all-will-be-fine scenario could already be ruled out as unachievable by the latest in the 2010s, at least for those ready to do the unrelenting maths (the IPCC - and various other studies forecasted that the 1.5° limit would be breached in the 2030ies and the 2° limit in 2050), and a scenario of 7 to 8° Celsius more in 2200 with the tropics having become physically too hot for humans to survive without air-conditioning and middle latitudes having turned into arid areas was always an option most unlikely, as long as human ingenuity could find ways to stabilize the climate. The only question always was and has been:

when? When would mankind understand what was at stake and could they overcome their ingrained mistrust of fellow human beings. But with so much and life itself at stake it is and was always inconceivable that common sense would not prevail over unwarranted distrust against other people and nations. **The challenge drives the reaction and if the only choice is A. accepting and at most limiting destruction or B. controlling the climate, stopping destruction and restoring nature, what do logic and reason tell us mankind will choose?** When the fight for the spoils the planet had to offer turned into a fight for survival that could only be won together, pure self-interest turned nations into allies. It just took far longer than those who understood the problem could ever imagine and for some time populism drove people in the opposite direction that should have been taken, like spoiled kids not ready to give up what they considered their birthright, forgetting that no such thing had ever existed and history always had been a struggle for survival. The struggle had just reached another, a global level, as the laws of nature proved unrelenting to wishful thinking.

It was a hard and long path from **a parasitic to a mutualistic relationship** between the dominant species - humans - and its host - earth. And this process resembles a perfect case of evolutionary pressures forcing adaptations in the parasites behavior to ensure its sole hosts survival. Literally gorging oneself on food and goods was never a clever and sustainable way of living, but leaving a comfort zone is never easy. The more so one reinforced by lack of education, social pressures like norms, traditions and lifestyle trends and an unchecked marketing business. This

proved too much for individuals as well as societies. Only the pressure of mortal danger, like a life threatening disease, leads to sustained behavior changes. Just as the obese patient with a failing heart is ready to change his/her gluttonous habits, mankind needed a big push to move towards a sustainable lifestyle. For decades scientists` exhortations, just like a physician`s to his/her obese patient, fell either on deaf ears or at least could not overcome individual and structural (a business system with huge profits from established technology) inertia. Bloated bodies and bloated lifestyles follow ancient genetic reward patterns not adapted to a post-industrial society of excess and constant pampering and are hard to overcome by sheer will power. Therefore if anybody wonders, in retrospect, why it took mankind - literally - decades to adapt to the obvious, despite having the theoretic advantage of an advanced rational brain, which viruses and other parasites have not, the reason is clear. The changes started by the industrial revolution proved too fast and too thorough for Homo Sapiens to continuously keep up with them as a society or as an individual. But our power of understanding at least was good enough to adapt in a dramatic way to overcome at least the worst dangers we had brought onto ourselves. Yet, just like with severely obese patients, calorie restriction itself proved insufficient in the short term. A well thought through and continuously monitored change of diet, a healthy nutritional regimen, is the best long term plan for obese patients who want to lead a long and healthy life, but it is nowhere enough to ward off life-threatening events like heart attacks or strokes. Then medicine and/or surgery, however unpleasant and despite their potential side effects and risks, are needed to save a patient`s life. There is no alternative to certain

death. Similarly the planet needed a balanced carbon diet for its long term health. This would have been sufficient had it started soon enough, but again as our comparison to overweight humans - a majority of adults in rich countries in the first half of the 21st century - shows, a change of habit was postponed and postponed. Procrastination ruled until it was too late and danger imminent. Only then did we finally focus our attention and resources at the problem wholeheartedly, using all our wits to stop the raging, killing fever by cooling it while trimming down the fat, the carbon in the atmosphere. Too late for many species who died out, and islands and coasts that were submerged, and people that died in climate induced disasters or conflicts. But not too late to turn back from the brink of a hothouse climate that would have collapsed most of our ecosystems and civilization as we know it. Most of the fears that were pushed from Malthus` time at the beginning of the industrial revolution onwards that we would become too many and would run out of space, food and resources from energy to ore never came true on a global level. There was always enough time and there were enough possibilities to react to such problems, even population growth. Such problems – which occurred again and again in the past - had never proved more than a temporary dent in mankind`s relentless development into the dominant species on the planet. But climate collapse doomsayers had a point when they warned about slow moving changes that would speed up once several tipping points were passed and that would turn the world`s climate into a runaway train on a downhill track, a development hard to stop and reverse that would push away too many of the foundations on which our human society rested to keep a majority of people alive. There was a reason to fear such a

dystopian future. Scientists and climate activists were not depressed by the world behaving like fools for nothing. But it was never realistic to believe that mankind would harm itself willfully once a **mental tipping point** had been passed in a majority of people, once disasters and education had made clear what was at stake and the costs had become clear, as long as options remained to control the climate. The question always boiled down to when: to when uncoordinated individual action and just as uncoordinated action on the national level would come together into a coherent plan of action, a **global climate stability program**, instead of a patchwork of sometimes counterproductive activities. And the **when, not the if** determined how much destruction was caused by our ancestors` reckless and inconsiderate behavior as individuals and society. The late **when** decided why so many species died out and ice was lost, with action postponed by a lack of understanding (education not science, by the latest in 2015 there was a 99.9% agreement in the climate science community) and determination.

Therefore today with **temperatures at** what most scientists believe to be **the optimum for mankind,** comparable to the 1980ies, moving in a range of 0.2-0.4° Celsius [0.4° on average for tropics to temperate areas and 0.0° in the polar regions to keep the ice sheets frozen] above the pre-industrial average [0°, which was too cold for comfort in northern latitudes] and sea water levels hardly rising anymore and most ecosystems in recovery mode, we can claim victory in our self-inflicted war with nature itself. Not because we really won, for that we lost too much and too many lives, far far more than in both world wars together, but because **we made our**

peace with nature and adapted our lifestyle and business models **without giving up our prosperity**. Mankind was never richer or more equal, as an existential crisis necessitated a joint effort by all and everyone, and because **the big business of the last 150years was climate stabilization and the recovery of natural habitats**, which did help a lot to stabilize the climate as well. Yes, **we helped nature to nurture itself back from the brink of breakdown** and turned that into the biggest business ever, spread out over all the globe, spreading wealth and higher standards of living in a healthier world. With **half the planet a dedicated wild sphere** where humans are only guests and the success of the **third agricultural revolution,** which together with the ever increasing urbanization enabled the rewilding, the world and mankind have started on a track of long term mutuality.

Yet there is still quite some way to go. Oceans, according to our best understanding, will take many more centuries to stabilize, from sea level rises - if scientists work out how to completely stop polar ice shields from melting even at the much reduced pace of the present - to acidity levels, still far higher than in 1800. At least sea temperatures have very gradually returned to a level comparable to the 1980ies. But many ecosystems took such a hit that due to the loss of millions of individual species, their survival in their entirety would have been in doubt without human intervention. And it will take more centuries for slow growing forests and coral reefs to stage a complete comeback to all their former splendor and size, but after 150 years of ecosystem restoration and rewilding we truly have come a far way.

This, now, is the story of how we nearly hit the wall in the **runaway train** our world had turned into and by which means we managed to avert disaster, turning the world into a better place.

The world, only a few generations ago, is as ridiculous to us as the middle ages with their witch hunts must have been to any of our educated forefathers at the turn of the millennium. Or how could you explain that our ancestors killed of their fields from soils to insects to stuff their bodies with sugar and meat to the point of individual breakdown against all advice, with run off from the fields creating dead zones in the oceans. How could you explain that they cut down life supporting woods for throwaway tissue and fished precious sources of protein into extinction. That they actually paid subsidies for carbon fossil fuels from coal to oil to be dug up and burnt, heating the planet and filling lungs with particulate matter to choke on. That they gave up using their bodies and wasted their lives sitting and staring at tiny screens, shopping as cheaply as possible for goods they did not need and that filled the world with **waste, just like the excrement of a parasite**. **Overgorging** beyond what was good for them or the planet in all perceivable ways, truly wasting away their lives and the planet they depended on.

It is no wonder that such a society did not listen to scientists` advice and lost its chance to easy redemption.

Before we work our way through the decades to look at mankind`s failures and successes to get an idea of what happened when, looking at the hard facts of history, let us start with a short overview of why things went wrong and what measures saved the day.

Who is to blame for the disaster? Despite trying to keep things short the list of basic reasons is long even without mentioning individual missteps. This can not surprise as otherwise the problem could not have festered for decades.

And if you are surprised how often scientists (not all but most) pop up in this blame game do not forget that in an emergency like the climate crisis or a pandemic there is always a hierarchy starting with experts at the top informing and convincing politicians and journalists who inform the public and in the case of politicians make decisions. It all starts at the top therefore, but climatologists did not act up decisively on their knowledge (which was much greater than scientists` understanding of a pandemic), leaving politicians and the public in too vague a state of understanding to set off on a path they felt could threaten the comfortable status quo.

So here is my list based on my research and the insights we have gained in the last two centuries. As mentioned above only major reasons can be listed if one wants to keep the list from running to a hundred something pages:

1. structural and mental inertia in the economy, people, society and science following the old human trait of preferring what we know, the status quo,

especially such a comfortable one, and the difficulty and exertions necessary to create a different system

2. greed among those who profited from the status quo, especially from burning fossil fuel
3. the influence and disinformation those profits paid for
4. an economic system biased towards destruction instead of protection were nature had no value as long as it was not plundered
5. lack of understanding due to underwhelming teaching of geosciences in general, but especially climate risks
6. lack of understanding due to pro and con reporting/TV-formats that led to an impression of the whole idea being doubtful when the climate change deniers had no scientific insight to underpin their unwarranted doubts
7. scientists inability or lack of desire to push and lobby hard for the necessary measures with provocatively clear language instead of confusing the public with scenarios of vague probabilities; maybe demonstrations or hunger strikes by scientists could have hammered the point home, but that is just a crazy idea of mine
8. politicians lack of understanding (3+4+5+6+7) and desire to postpone unpopular decisions to remain in power
9. scientists "need" to be 100% correct, to keep their "standing" in a peer reviewed, grant-dependent science system (1+7), while in the middle of a giant experiment with too many variables to predict an outcome without doubts, in a situation when a 99% chance of disaster should have been more than enough as a call to action
10. scientists spreading the "climate lie" of overshoot scenarios that led the

public and politicians (8) to believe the thresholds of 1.5° or 2° would not be passed if only we would cut emissions quickly enough long after that was feasible, stopping any comprehensive plan to stop warming for decades

11. scientists underrating tipping points and cascading events that led to an ever faster heating of the planet that reduced direct human emissions could not stop
12. journalists and scientists accepting **climate change** as the term to describe global warming, despite its cute sound so at odds with its destructive potential and incredible speed, while nobody mentioned the eery similarities between mankind and a destructive parasite killing its host: earth
13. the global scale of the challenge with its free rider problem keeping countries from enacting adequate measures out of fear that their own economy would be disadvantaged and jobs lost despite their, especially bigger countries like the US or EU, ability to increase duties on imports with less exacting standards
14. politicians not just for failing to act but also for pretending to work on the problem by pledging cuts far in the future without enacting the necessary steps or even coming up with a comprehensive plan and covering their tracks with creative accounting and greenwashing
15. scientists for never coming up with a comprehensive plan that could stand hard-nosed scrutiny instead of offering a range of emissions paths without guidance on how to achieve them and no calculation if and under what circumstances and costs they would have been attainable
16. politicians and lobbyism from companies and unions for pumping

more money into the extraction of fossil fuels than into renewable energies

17. people because of their taste for ever bigger cars eating up any efficiency gains
18. people and marketing for gorging on ridiculous amount of gadgets and clothes, fast fashion being a good example
19. globalization for sending goods several times around the world during their lifetime to save a few pennies
20. institutions and politicians for considering burning wood as carbon neutral despite the time-lag of several decades necessary to get the carbon back out of the atmosphere if - and that was a big if - the trees grew at all, and the destruction of existing forests and habitats to satisfy an ever increasing hunger for "carbon free" energy (14)
21. industrialized farming for its focus on volume destroying soils, peatland, forests and more, while pumping incredible amounts of methane and N2O into the atmosphere
22. people for the ravenous appetites for cheap meat and other unhealthy food instead of being ready to pay for quality and eat only as much as their body actually needed
23. populist politicians for promising good times and actively fighting common sense policies to stop a climate disasters and voters for believing the nonsense the populists spouted
24. climate activists for confusing the fight for climate stability with a fight against capitalism, attacking it outright, endangering the economic fundamentals on which prosperity was founded, thereby even endangering the financial and material resources necessary to mitigate

climate`s destructive tendencies and any possibility to stabilize the climate with the help of technology

25. climate activists for arguing from the moral high ground against a consumerist society which lead to a countermovement of people who felt pissed off by being labeled dumb destroyers of the future
26. religious leaders and believers for tolerating the destruction of creation and creatures
27. unfulfillable pipe dreams of Arctic riches in a collapsing environment on the edges of the world that needed nothing less than more fossil fuels heating up the planet that led to the outrageously foolish believe there would be winners amidst a collapsing climate and ecosystem
28. climate change deniers for filling their heads with fake news for so long that they fought a quixotic battle against science and their own interests, endangering their own kids` future
29. Distractions: for there was always something else that was more urgent or important from terrorism to plastic trash (I know that sounds absurd in retrospect with plastic still forming such an important part of our lives) to economic crisis or unjust societies or pandemics that kept
us from focusing at the one existential threat. Why focus on something complex that needs long term coordinated planning when you can fight something that is the crisis of the day. What would procrastination have been without changing distractions that kept us busy doing important stuff (sarcasm warning).
30. Scientists turning the year 2100 into a fetish, as if that date was any more important than any other date, instead of focusing on the date when temperatures would breach the limit of 1.5°.

What stopped the worst developments and saved the day in the end?
What changed the dynamic from destruction to rescue?

1. disasters, disasters, more disasters and an ever increasing amount of numbers (2) that showed that the earth was heating up faster than predicted and quickly passed thresholds (1.5°) we were warned not to cross, and the fact that more and more species were dying out
2. measurements, measurements, measurements, not just showing the state of the climate in all its complexity and interactions, but detailed information with respect to emissions, ecosystems, soils and much more
3. better education and reporting together with a new language like climate crisis or the threat of a climate collapse
4. mankind reached a **mental tipping point** (1+3), a sign of evolution in progress, that finally led a large enough group of people to realize the danger, making them ready to act
5. honest counting of emissions: **TGGEs** (2) (Total Greenhouse Gas Emissions from the beginning to the end of a product`s life/pronounced: ti:dji:s)
6. a tax on all TGGEs (started as a carbon tax and depending on 5) that payed for every activity that sucked carbon out of the atmosphere and stored it away leading to a re-balanced carbon cycle
7. a slowly but steadily developing **Green Technology Revolution:** new technology to produce renewable energy ever more cheaply and to store it as synthetic fuels, in better batteries and in a plethora of other ways; new ways of producing steel and cement and the use of new materials

that replaced them; a minimum waste economy based on reduction, recycling and reusing; carbon capture from the air to store it and even better for turning it into a resource like in the production of synthetic fuels; synthetic fuels themselves as they allowed traffic of planes, ships, trucks and bigger cars batteries did not allow; and much more

8. **White revolution:** a term that covers a plethora of factors leading in the same direction: **healthier lives**. And while all of those inventions and changes of lifestyle led to better health, some of them had dramatic repercussions for the planet itself. A world in which people ate less meat and quality food of the right amount while using their body to get around turned into our world where obesity is unknown, in which less and less food was wasted and less space fed more people. In earlier times people always looked for drugs to remain healthy and happy, but we have learned and been taught that our bodies, well fed and used and rested, are the means of happiness and health, at least in normal circumstances. With genetic mishaps being repairable it is only random occasions that need medical attention. Knowing ourselves better destructive marketing has become illegal, a gradual process that started with tobacco at the end of the 20th century, helping us to overcome our genetic disposition to hoard food - those obese bodies - and things, turning our economy from production to services and nature management ensuring a healthy local environment and quality of life.

8. The **Third Agricultural Revolution:** Once, actually not too long ago last century, mankind was worried that it would run out of food due to dramatic population increases and a lack of arable land. Again and again scientists had warned from the 18th century onwards that this combination

would lead to massive famines and millions of death. But while this was true in local cases it never proved true on a global scale. The 19th and 20th century led to the second agricultural revolution, an industrial revolution where machines, chemistry and breeding overcame limits to labour, nutrients and the original food plants restrictions while effectively fighting pests, allowing dramatic increases in food production. Together with better transport and storage from fridges and freezers to canned food this led to the surplus in calories that did not just allow the world to avoid global starvation but actually led to the obesity pandemic of the 21st century we learn about in our history classes, where human life spans, but especially quality of life, was not restricted by a lack of calories, but by a surplus. With food companies feeding mankind **ultra-processed food** making use of our predilection for sweet, salty and fat food our bodies evolution craved to turn a profit a malnourished world did not lack calories but nutrients and fasting. All the while the most serious threats to an ongoing success of this industrialized farming model were not just related to the climate and the soils deterioration and erosion, but also to the seemingly limitless taste for animal products from meat to fish to milk. And while the gradual and slow-grinding white revolution (7) played an important role in reducing the consumption of animal products by switching to healthier plant based alternatives and fewer calories and hardly any ultra-processed foods it alone would not have been sufficient to solve the 21st centuries bottleneck in food production. A solution had to be found for the lack of fertile land and the increasing appetite of the billions of formerly poor humans. For it was less the rapidly increasing population in Africa - all other places did not grow anymore or only in a manageable way in the 2nd

half of the 21st century - that was driving world population towards the 10 billion mark, but the over-consumption of animal products that needed more than 60% off the global agriculturally used area. Had the world turned quickly vegan or at least vegetarian it could have fed a much larger population on far less land. **But due to the double development of meat from plants and cell cultures global meat production by raising animals - including fish - collapsed** in the second half of the 21st century, except for traditional herding on pastures to keep grassland ecosystems healthy, decoupling food production from the constraints of limited land. It was this quite sudden change in farming that set more than a quarter of the world`s land surface free, the area once used to produce forage crops to produce animal products, for rewilding and ecosystem restoration (10) that also turned these areas into carbon sinks instead of sources. The other part of this - probably final - agricultural revolution solved food production`s problems with respect to droughts, storms and collapsing soil fertility by moving a major part of plant production indoors as had already become common for mushrooms, which played an ever increasing role in human consumption. So while the second agricultural revolution vastly reduced the limits set by nutrients and traditional crops and breeds, the third one did the same for weather, soil and natural antagonists from pests to diseases the second revolution could not sufficiently deliver on a long term scale. In a closed system there was simply no danger from pests, fungal or bacterial infestations or competition from unwanted herbs enabling the whole food chain to become free of chemicals as the part of the production that remained outside was cultivated in organic farms to keep the soils, water and environment healthy, turning farmers into more than food

producers as they became landscape guardians and carbon capturers. Producing fresh plant food, especially vegetables, in vertical farms and cultured animal products at the place of consumption 365days a year without care for the weather did not just produce more high quality food (40 harvests a year in vertical farms) and reduce transport times from farm to market dramatically, but - as mentioned before - set vast amounts of land free as well as needing far less water (around 95% less).

9. Urbanisation and **urban densification**, a process that had gone on for centuries got another boost from climate disasters, the third agricultural revolution, new laws and restrictions aimed at undoing urban sprawl and urban planning to cool cities down, concentrating ever more people in an always smaller area where there ecological footprint was much smaller, freeing more land for rewilding and ecosystem restoration (10). Urbanisation, together with increased education for girls, also led to fast falling population growth, even in Africa.

10. Ecosystem Preservation, Restoration and Rewilding: what started out small scale, by trying to rescue individual species through captive breeding, the storage of gene material and the establishment of national parks to protect whole areas, grew into a global program to preserving what was left, for rewilding where possible or ecosystem restoration where the original ecosystem had been degraded so far that a helping human hand was needed to regrow it. A special case are the oceans where ecosystem restoration had to include localized carbonate deacidification of oceans to keep reefs alive and even efforts at breaking up the intensive layering that stopped the upper layer of the oceans from mixing with lower, colder and oxygen rich water.

11. Climate Stabilization

All aspects mentioned above would not have been sufficient without a dedicated program to stabilize the climate in the short and long term. Important aspects without which this would not have been possible are:

a. Global institutional co-operation and long term planning: **Global Climate Stability Governance Body (GCSGB)** based on the example of technocrat led politically independent central banks. The idea was to become independent of the political cycle and nationalistic pressures so unsuitable for a common global long term strategy and ensure that the decisions were made by expertise knowledge based on the vast amounts of up to date data collected (2+5). Its sole raison d`etre was to make sure that at first global temperatures did not overshoot the 2°C mark and then to gradually lower global average temperatures back to the optimum range of around 0,7° and keep it there forever. So just like central banks keep inflation in check, the GCSGB keeps global average temperatures in check.

b. To do so it needs all the necessary data that is collected by a multitude of institutions and companies and coordinates those efforts.

c. Based on this information it sets the price for the global TGGE-emissions tax and the price that is paid for taking carbon out of the atmosphere and storing it, which can mean **green carbon capture** like a farmer enriching his soil, the restoration of rain forests and increased algae growth or **technological carbon capture** like the underground storage in former oil deposits from direct air capture.

The relationship between taxes an emissions and earnings on storage can in the future actually switch roles if the world cools down too much and more TGGEs are needed to warm the atmosphere.

d. **Solar Radiation Management** (SRM), colloquially known as cooling measures: in order to avoid overshooting the 2°C mark SRM methods proved necessary as TGGE reduction measures and carbon capture would have taken far too long to stabilize a rapidly deteriorating climate. Those measures included different technologies on different scales maturing into the second pillar of managing a stable global climate besides **greenhouse gas atmospheric concentration management**. It started with local measures to turn cities from heat islands into bearable places (**green cooling** with plants + increased reflection surfaces) and measures to cover glaciers or increase their reflectivity to keep them from melting too fast. To keep down global temperatures those local efforts had to be gradually - to keep side effects under control - scaled up on a global level by managing cloud cover and especially by increasing the reflection of sun rays in the stratosphere. This was achieved by spreading tiny particles throughout the stratosphere in the tropics with the help of drones following prescribed routes and constant measurement of their impact and how stratospheric winds spread them around the globe. To make sure all areas were cooled according to their needs some areas were cooled more intensively. Foremost this meant cooling the polar regions during their respective summers - there was no need to do so in winter when no sun rays reached the polar areas and in spring when ice cover and fresh snow kept the local albedo at a maximum - as otherwise the temperature difference between them and the tropics, which did not warm as quickly,

would have increased, destabilizing global wind patterns and ocean currents, especially the jet streams and thermohaline circulation. And while SRM in the tropics has been stopped many decades ago now, the polar regions are still being cooled to keep the ice shields from melting too fast, although an additional stress has been put on using particles that once they have dropped to the ground, something that happens much more quickly in the polar regions than the tropics, increase the albedo at ground level.

12. AI, robotics and drones as all those vast amounts of data (2) would have been of no use without the calculating power and pattern recognition ability of massive scale AI climate modeling. And SRM fine tuning would have been impossible without drones seeding the stratosphere or clouds precisely while gathering real time data. Which after all means that the human ability to control the climate - and maybe some time in the future the weather too - depended on knowing enough variables and being able to calculate their interactions, turning what was once supposed to be a chaotic system - not because it did not follow the laws of physics, but it included too many variables for mankind to be able to predict an outcome with a high probability - into a system we understand and can at least partly manage.

The history of climate stabilization and ecosystem restoration

All the developments step by step:

20th century

The problem was well known and understood from the 1960ies onward. But with temperatures in an optimum range it took until the end of the 1980ies for serious discussions. At this point, in a peaceful, American dominated world after the end of the cold war, with communist industries collapsing, a concerted effort for more energy efficiency and renewable energy together with clear restrictions on fossil fuels and a price on carbon would have been enough to stop the temperatures from crossing the infamous **climate stability tipping point. This means emissions reduction alone would have been sufficient to keep the world`s climate in a stable range**. But decisive action was not undertaken. Too strong was the influence and lobbying power of the fossil fuel industry and too ingrained a life on the back of its cheap energy. True, a first international agreement was signed, the Kyoto Protocol. But it was toothless, halfhearted and the most important players, the US and China, not on board or under no obligation whatsoever. Neither was aviation or shipping. Emissions were - if at all - only cut on paper but not in real life. In the end this was the time when most countries started to use **accounting tricks instead of real reductions**. The only true gain for climate stability came from a ban of **CFCs**. But that was not based on fears for climate stability, but on fears about a shriveling ozone layer, a fear, with hindsight, a bit

overblown as ozone - like carbon - is part of a natural cycle - different at different longitudes and therefore hardly a threat to any populated areas - while people feared its complete and enduring loss. The ozone layer does have natural lows in the polar regions in spring - and only there and then - whose depths were increased by CFCs, another problem that has been solved for a long time. Yet this fear for our planet`s sunscreen at least showed that mankind could collaborate if the threat was felt deeply enough. On the other hand CFCs also proved that something you forbid on paper can still be produced in unregulated factories if everybody just leans back and no true check-up is undertaken. CFCs still leaked into the atmosphere in the 2020s, but at least at a vastly reduced scale.

Another point about the 1990ies was the onslaught of **climate change deniers**, who were allowed in public main stream media to dispute the basic facts of climate science, sowing doubts about the truth of climatologists` calculations in the minds of many. Foolishly - or because it increased attention and therefore income - journalists wanted to give both sides of the argument a hearing, ignoring that the deniers had no scientific research to prop up their claims and therefore no argument except their ignorance for scientific facts. **But climatologists were also to blame.** Instead of politely arguing with ignoramuses they should have simply stated that they would not debate with "fools without facts", as one of my colleagues wrote last year, and should have behaved much more aggressively all in all while making their point. Driving home the danger would have been the task of every individual in the climate science community. Alas, again with hindsight, it is easy to understand that scientists at the time were neither trained to do so, nor did they have the

will or inclination to risk their reputation and funding by becoming the spearhead for a ruthless information campaign. The climate had no well-funded lobby and scientists were too fussy about being 100% right, a fact that had something to do with reputation and how academia works, whereas a topic as complex as the interaction between humans and climate would have needed a **safety first approach** that would be ready to act as soon as dire results seemed most likely. Yet scientists made another big mistake by taking up **the term climate change**, favored by the fossil fuel industries, a term so belittling of what was going on that today we consider **its use one of main mistakes** made in fighting what would have been much better termed global heating and later climate crisis or climate collapse. **Words shape minds and minds shape actions**. A hole in the ozone layer sounds immediately threatening and action followed promptly. Climate change, always harder to stop than CFCs, did not confer any idea of the mortal danger a destabilizing climate would bring. Even today it still sounds rather cute. And it helped deniers to change tack in the first decades of the 21st century when it simply became ridiculous to argue the fact that earth got hotter and mankind was to blame for it, by pretending that the climate had always been changing and that this was simply natural and not much could be done about it anyhow. A strange line of argumentation if we consider that it was mankind who pushed the climate out of a narrow band of stable temperatures that had existed for about ten thousand years. How could we do anything about that, our own actions? But it helped to influence - or excuse - the actions or rather inaction of many important players in the climate game in the next three decades, despite all the shocking scientific studies that came out in ever increasing numbers.

2000 to 2020

Scientists still do not agree on when the earth climate tipped into accelerated heating mode, but most agree that quick and deep emissions cuts in the early 2000s might just have been sufficient to stop the climate from collapsing without further human intervention. But basically the first decade was squandered without any real action, with deniers and profiteers still much in control in a world ruled by old males who would not see the results of their disastrous policies and whereas the second decade at least saw the first comprehensive climate treaty in Paris in 2015, it proved as toothless as the Kyoto Protocol before, and emissions rose for the rest of the decade not stopped by empty promises or uncoordinated action focused on reduction alone.

Yet it was not just the politicians with their desire to postpone hard decisions and pass them on to their successors. The public is also to blame in their hunger for more and more consumption. This after all is not just the decades that saw the incredible rise of China, which tried to copy the American way of life, a life based on cars, meat and endless shopping that soon turned it into **TGGE**-emitter number one. Their **T**otal **G**reenhouse **G**as **E**missions, which include all emissions of a product or service from beginning to end, literally killed of any chance of reigning in global heating by emissions reductions alone. Instead of reductions the lid blew off and year after year a new emissions record was broken. Yet it was not just China and the other emerging countries it tagged along in its wake who all tried to emulate the wasteful western lifestyle that seemed so desirable, despite the fact that it led to immobility - of obese bodies and cars in traffic jams - and was unsustainable and earth destroying. No, the

rich world also was much to blame with their keenness on driving ever bigger cars, a fast fashion fad that led to billions of clothes literally produced for the waste bin and the rise of budget airlines that flew, largely untaxed, from A to B for dumping prices.

The only big breakthrough was in alternative energies from wind to solar power, based on generous feed-in tariffs, especially in Germany, and scaled up cheap production in China that made alternative energies competitive during the second decade of the 21st century even in a system still based - if not to say biased - on fossil fuels. But apart from sustainable energy production no big technological breakthrough happened with especially the transport sector proving hard to change. Instead of pushing bikes and public transport as pioneered in the Netherlands among others, China had turned into the world`s biggest consumer of cars, despite its high population density, which would have favored public mass transport. And China amongst many other countries also opted for a "carbon-free" technology for cars that was supposed to enable them to go on with their lifestyle of immobility, wasting precious resources and heating up the climate which did not care for marketing and accounting tricks. True electric mobility played a big role later in the century, but its introduction in the 2010s and 20ies was a prime example of uncoordinated strategies that were not thought through as batteries produced with and run on electricity from coal fired power plants pumped more carbon into the air globally than standard fuel powered cars for years. Especially for those huge and wasteful cars so en vogue at the time as they needed lots of batteries. Another prime example for counterproductive foolishness was Germany – the ancient home of cars – were a tax payer funded push for

electric cars in the 2020s coincided with a shut-down of nuclear power plants (an old-fashioned and long forgotten way of producing electricity carbon free) that meant cars were powered by burning lignite, the most carbon intense fossil fuel of all. It is hard to imagine a much more ridiculous strategy to cut emissions, than one that actually increases them. But lying to yourself – just switch your car`s engine and all will be fine however much you drive - did not impress the climate which started to pump extra carbon into the atmosphere from burning or dying plants, especially drought stricken trees who did not get enough moisture in an ever warmer environment, and soils. This was the time when huge forest areas, especially in the rapidly heating boreal forests of the north, turned to net emitters instead of carbon sinks, adding to the global carbon foot print, causing ever more disasters. At the end of the second decade already about ten per cent of all emissions came from collapsing ecosystems, while those natural carbon sinks that still functioned, like the tropical rain forests were cut down relentlessly and had already lost nearly half their carbon storage ability since 1990. What could have been worse with respect to the carbon cycle than a two-pronged attack that did not just pump more carbon into the atmosphere from fossil sources, but also restricted nature`s ability to suck the carbon out of the atmosphere again.

We have been unable to pinpoint the global climate tipping point to one year, but all scientists agree that it must have been in the 2010s or by the latest in the early 2020s. This means that from that point onwards it was never feasible that emissions reductions alone would suffice to stop the climate from heating itself up. Still, the overall reaction from politicians to

populations was denial or at least ignorance of that fact. It is a bit hard to fathom how many actually understood that emissions reductions as agreed on in the Paris treaty would not be enough for the world to remain in a stable climate. We have to remember that most of the disasters at the beginning of the 21st century happened far away from population centers in the rich world, mostly in the Arctic and Tropics and scientists, in the form of the official IPCC panel of climatologists, played an ignoble role in the process, too, by telling the world it would be able to remain below 2° C or even 1.5°C in the year 2100, without clearly explaining that all scenarios for such an outcome were **overshoot scenarios** in which the temperature would pass those temperatures, but would be cooled down again until 2100 by sucking out Carbon from the atmosphere. According to the best research we have, people – and that would include politicians, who had no more understanding of the complex topic than most educated people – **did not grasp that we would overshoot the temperature limits** mankind had set itself and that this would lead to dire consequences for ecosystems and long term climate stability. One important point completely overlooked at the time was that **making a fetish out of the year 2100** was detrimental to many sensible mitigiation efforts. Looking back from the 22nd century we naturally feel left out of any longterm plan then devised, despite the fact that it was always clear that our century would have been hurt much more than the 21st, especially by the rising sea levels, which start out slow but go on relentlessly - and from a certain point onwards can`t be mitigated by any other action than giving up land. And not just any kind of land, but the most densely populated areas with some of the most iconic cities mankind ever built. Even more important so

is the fact that looking forwards from the 2010s 2100 seemed so far away that most people did not understand the urgency. **2100 was never the decisive year.** Stopping the temperatures from breaching 1.5° or at most 2° above the pre-industrial level should have always been the goal. Not overshooting these temperatures by pumping ever increasing amounts of carbon into the air and hoping that later on we would be able to suck all that carbon out. Especially as no politician or the public at that time was ready to consider alternative additional strategies. No, this was the point in time when scientists should have spelled out clearly that without a **comprehensive global climate stability program**, we would be unable to stop the climate from collapsing and turning into a hothouse. But whereas all scientific calculations already included massive amounts of captured carbon, all political plans - as mentioned before - were based on reductions alone, with a few more trees planted here or there in monocultures that harmed local ecosystems often more than not. That was the beginning of the infamous **greenwashing** activities when projects from water power to tree planting were talked up as climate friendly or meant to offset emissions whereas in reality somebody wanted to gain financial short term profit one way or another. And reductions themselves were still not counted as TGGEs over the whole lifecycle of a product or all aspects of a service. The simple fact overlooked in all calculations was t**hat any newly built thing comes with a mostly heavy carbon footprint**. This means that our forefathers did never calculate with the **“interest”** a high carbon outlay accrued if you “spent” carbon producing something and had to wait until it was compensated by reduced emissions later. Basically, that means that all calculations about technological mitigation, from electric cars to

any energy saving devices, were too optimistic. If you add in the extra carbon from natural sources like trees, peat and soil that leaked into the atmosphere in ever increasing numbers together with the ecosystems deteriorating capacity to store away carbon our forefathers finally unhinged the carbon cycle for good. Or to put it differently: we did pass the climate stability tipping point!

But only a little bit. So the sad truth about the second half of the decade, but especially 2018 and 2019, is that the public in at least a few places like Australia and Western Europe had mostly woken up to the dangers and that the first major, still peaceful demonstrations, mostly led by pupils, following the example of a Swedish teenager, took place, but that the world actually saw a backlash from people who feared for their lifestyle and prosperity and prevented a concerted push for reductions. If that push had been based on carbon pricing, and restrictions on climate harming activities from certain farming methods to fossil fuel mining, together with a broad strategy to quickly suck out carbon by protecting existing carbon sinks like rain forests, soil carbon sequestration and a big push for direct air capture turning CO2 into synthetic fuel it could still have sufficed to ward of the worst. Together with local measures to increase the albedo in cities and on glaciers to reduce local temperatures for humans and ice, such a strategy would still have at least stood a chance of stopping the climate from collapsing without the necessity for further "remedial action". But, to put it bluntly, no - and I mean zero - effort was put into creating a carbon capture industry and no restrictions on farming, cutting trees or even fossil fuels were put in place. And carbon pricing, so finally established in a first batch of countries, was far too low to have much bite.

The most ironic point came right at the end of the decade when Australia, the country most at danger from the heating planet among rich countries, from a dying Great Barrier Reef to drought to forest fire, voted for a new big coal mine to open in the 2020ies, only to be “punished” by the great fires in the summer of 2019/2020. This was just one of the most outrageous examples to show how large parts of the population were still in denial about the dangers a rapidly heating climate posed and the beginning of the **great intergenerational conflict** of the next decade which pitched the young, who mostly were not allowed to vote, against there elders who, as the election of 2019 had proven, were hard to dislodge from the levers of power while they controlled the money and the media.

An important aspect during those decades and well into the 2020ies, underestimated for too long by historians, was the **underlying political antagonism between "deniers" and "activists"**. This was more than just the old against the young, those who had profited from cheap fossil energy, or in the case of poor countries wanted to profit from it, against those who feared for their future prosperity. Too many "activists" demonstrating for a stable climate were actually at least additionally motivated by their hatred for the established capitalistic system, deeming it unfair or even morally unfit. This was seldomly openly acknowledged, but the lurking feeling among many people that activists wanted to take away their comfortable lifestyle, that they were blamed for leading good lives - according to the definition of the day, which often meant being an obese couch potato, an idea that beggars belief nowadays, but also included the freedom to travel the world and live as you wanted - was not without truth. It was one of the

main reasons why no alternative or at least additional technological solutions were favored by the "activists". **If this was a moral question than only repentance would bring redemption**, which means that radical emission cuts driven by sacrificing cherished human habits from driving cars to gorging on meat would save the world. And although there was truth in the conclusion that activists had drawn that the world was overgorging to the point of destruction and that a change of lifestyle would be good for all and everyone, they were completely wrong in two even more important aspects. Namely pretending up into the 2020ies that emissions cuts - even radical ones - alone would rescue the planet, whereas climate scientists had already abandoned that hope and were betting on carbon capture as a backup plan. And secondly that those cuts were even possible, considering that complex systems full of physical assets and ingrained behavior needed decades to change. This was after all not just a question of mental inertia and bad habits, but of actual assets who either had to be replaced, causing an enormous underappreciated amount of TGGEs not present even in any of the climatologists calculations, or be shut, meaning people would really lead far poorer lives. That followed the old socialist failure that they might have created more just societies, but not by lifting the poor up, but by bringing down the rich and the middle classes into poverty. Making everyone poorer in this case would also have meant fewer resources and less money to mitigate and stop climate disaster! If the "activists" had stressed the necessity to adapt ones lifestyles in positive ways, good for health, wealth and climate, like trimming and slimming down an obese person instead of trying to cut into the muscles that powered humans or their societies they would have had a positive

impact. But by insisting on unachievable and unrelated goals they turned large parts of society not just against them, but also against any action to stop "climate change" as it was than still known.

The idea that climate policy would work like a Trojan horse, settling old scores between the radical political left and the "capitalists" by finally defeating the rich and powerful and creating a society more just, therefore was truly a disaster. By trying to rerun the old antagonism between capitalism and socialism many activists confused the excesses of a badly regulated market economy that was detrimental to nature and many people, with something generally bad. They forgot two things: Socialism had not lost without reason. It was unworkable from a biological perspective, unfit for our species, whereas capitalism came natural to human nature and was adaptable and resilient. And Socialism furthermore had never cared much for nature during its history, always being preoccupied with a struggle between classes. Hardly any political system proved that inconsiderate and therefore destructive to nature than the dictatorships that called themselves socialist countries.

By trying to paint capitalism as something evil in general "activists" did a big disfavor to their official goal of rescuing climate by mixing it up with something different, the non-life-threatening question of social justice, creating unnecessary enemies. Had "climate activists" cared for a stable climate alone and accepted all potential solutions based on the **golden rule that anything that helped stabilize the climate was good, and anything that heated it up was not**, the planet would have agreed twenty years earlier on a common policy. And as history has proved, their goal could be achieved by tweaking the system instead of trying to tear down the

foundations of a system in which so many people had stakes and as a result a lot too lose. Another failure was that they didn`t accept the simple truth that **a collapsing environment would hurt everyone**. By painting a moral scenario in which the losers were poor and innocent, and the rich the culprits who would not be hurt much - as if New York or Tokyo would not be hit by tropical cyclones and ever rising sea levels - they created a mental distortion in many a member of the rich world, assuaging the fears of the rich without good reason, while driving them up the barricades to defend their way of living, in which they could not see any direct harm to anybody in the near future. Drive people into a corner by blaming them for far off evil and you will find out that they will put up a fight. This is no excuse for the despicable policies especially in the US, but an explanation for people nowadays to understand why it was so hard to change minds then.

By 2019 it was clear that the blame game against the rich world had not worked and anyhow run its course with China far and away the greatest emitter of greenhouse gases for a decade and India trying to emulate its "success". Global emissions did not just rise but become more evenly spread showing that any country - and there was no exception - would jump onto the carbon fired growth wagon if only it could, perpetuating the mistakes of the developed world with every new round of development instead of trying to leapfrog with the help of solar power most poorer countries were so abundantly blessed.

2020ies:

The decade without excuses. The decade when all information with respect to the dangers of a rapidly changing climate was well understood. The decade when it was utterly clear that we had wasted so much time that we only stood a good chance to reign in the planet`s fever in a concerted action of all players and all methods, from reductions to negative emissions to what was then unbelievably still considered an esoteric endeavor, understood by too few people as SRM, Solar Radiation Management, something we more colloquially have come to know as cooling measures. This after all, was the decade before we breached the 1.5° and there was no physical possibility to remain below 1.5° without SRM, as was well known to climatologists. But instead of clearly making that case and stopping temperatures from passing this critical threshold they betrayed climate activists into believing the goal to be still achievable if we only cut down emissions fast enough, by more than 50% in a decade, without adding that even then we would overshoot that temperature for many decades. After years of procrastination and with no sign of any serious commitment to cutting emissions energetically - greenwashing endeavors that avoided honest accounting of TGGEs pretended batteries and burning wood to be carbon neutral, and no one counted the imports or the dumping of goods - the only thing climatologists offered was a numbers game, stating that the later cuts would start the deeper they would have to be, without ever accepting or understanding that there was a physical limit set by the TGGEs and the **carbon interest** of any new device (effects accumulating and increasing over time, comparable to interest paid on money), and even from decommissioning any old ones, to

how far and fast a complex system and society could turn a corner. This was like telling a giant cruise ship it should change course in a few hundred meters when its ability to do so was limited by physics and its speed at the moment to being able to perform that task in ten times that distance. Well, not really a reasonable option, but one still widely believed as nobody dared admit the truth, fearing.... We don`t know what really! In retrospect we are quite at a loss what exactly the problem would have been. Frustration at the foolishness of having let things come to that point is no way enough. Failure could have been pointed at politicians and decision makers in the (recent) past. Fearing that the world would abandon hope in the face of disaster is ridiculous. Just like the idea that people would have given up trying to make "sacrifices" by cutting their carbon footprint if they knew we would breach the 1.5° soon. The vast majority never had made any efforts as they did not understand the emergency as they were neither prepared for it sufficiently by education or politicians` speeches. Maybe it was the irritating idea, or disgusting idea to those activists who blamed technology and capitalism for destroying our future, that saving the planet needed more than just adapting mankind`s lifestyle. That there was no chance of preventing disaster without using technology. Would that truth have been so hard to bear? And was postponing admitting the truth not making everything worse by stopping the world from looking for alternatives? Sometimes truth can set one free and in this case could have set free a cascade of positive actions as not all and everyone was wasting their time. But the **climate lie** - the real one, not the one bandied around by deniers for so long that mankind was not to be blamed for the planet`s fever - that the world could still make it with reductions and life

style changes if only mankind would behave less foolishly put all and everyone in sleep mode instead of focusing action on the inevitable. The climate lie propagated by scientists themselves cost the earth at least a decade of inaction.

Nothing would have focused the minds of the public more than experts clearly stating what the problem was. This after all was the decade that started with the Corona pandemic which upended daily lives in an utterly unprecedented way with country wide lockdowns turning the world into a prison while the economy collapsed. Despite these extreme outcome a great majority of people followed the advice and supported the measures in those cases where experts and politicians had clearly explained what was at stake and why no alternative course of action was available at first. No country got through the crisis unscarred, but the outcome was worst in those countries were populists did not heed the advice of scientists and procrastinated for too long before they tried to outdo each other with overly drastic measures to cover their own failure. Some people understood that the Corona crisis was a template for the far larger climate emergency, but as soon as the crisis receded the world returned to old routines without learning the essential truth from the pandemic: all of mankind was stuck in the same boat and once it was rocked and upended everyone would have bear the cost. Co-operation and preparation could have stopped the pandemic in its tracks, just like it could have stopped the climate from deteriorating. And there was one more important lesson to be learned from the first big pandemic for a hundred years: If there was a will, there was no lack of money to finance what was needed and if a sufficient number of lives were at stake economic arguments took a back

seat, but only during an emergency and only for a short period of time. When economic destruction with all its accompanying side effects, some of which directly or indirectly led to higher death rates, reached a certain point, public opinion changed again. This turned into **the dogma of** new group of activists, not climate activists, but **climate stability activists: Keep the people healthy and well off** (do not destroy the economy, stupid) **no matter the financial cost!** People are ready to pay for measures that protect their lives and keep the global prosperity growing but not for measures that destroy it by focusing too much on restrictions. If people had a choice between prosperity and climate stability - however essential for prosperity in the future - most would choose prosperity as long as there was a choice. A forward looking policy for the climate crisis had to provide both: a stable climate and prosperous lives.

Yet however much the decade started with a pandemic bang - that quickly but not for long reduced emissions - this was also the decade of an ever increasing number of natural disasters from droughts to floods to storms with the warmer atmosphere and ocean intensifying natural trends. But it was forest fires especially in the boreal forests reaching epic sizes that changed many people`s outlook. According to original estimations forests in the northern regions, the largest on the planet should have grown faster in warmer temperatures. Yet this did only happen where far more moisture was available which simply was not the case in the vast expanses of Siberia and Canada with their continental climate. So instead of sucking out more carbon from the atmosphere trees stressed by a lack of water reduced their growth and carbon uptake, were devastated by bark beetles,

ravaged by fires or simply died silently, marking the beginning of the final stage of the great deforestation of our planet that had started with mankind clearing space for farming and now ended in a few decades where death by climate change finished what continuous logging would not have managed on a comparable timescale.

Together with the other events that proved far faster than estimated from the rate at which the great polar ice masses were melting to the rate at which permafrost vanished this convinced many scientists that the global tipping point must have been passed and that the planet was heating up by itself ever faster. The stable climate path of the last ten thousand years had finally been left and the world tipped into its fastest period of heating up, the 2020ies and 2030ies, in its whole history.

But individual opinions could not easily change even the official scientific consensus, which took years to develop. Studies had to be done, results published, those results evaluated and discussed and finally put to paper for politicians many years after the scientists themselves had understood what was going on. The fact that the scientific consensus on which politicians based their decisions, represented by the official IPCC reports, had a time lag of at least 5years meant that the IPCCs predictions in a deteriorating world were generally too optimistic and because of that it took until the end of the decade when an El Nino event pushed the average global temperature over or at least near the 1.5° limit (there was never a 100% agreement on that, the official data said 1.47°) that at least the science community was convinced that the tipping point had been crossed.

And those same scientists who had argued for radical cuts at the beginning of the decade had to admit that nothing remotely approaching this had happened. A Corona dip, a post Corona spike followed by a leveling off and then a slowly grinding reduction are not the equivalent of radical cuts after all. Renewable energies had grabbed an ever bigger share of the energy market and became ever more cost effective, but the fossil fuel industry was still jugging along merrily, too, not seeing the end of its road right in front of it, losing investors billions in the next decade. One of the main reasons why fossil fuels still played such an important role was the fact that they were so hard to replace in the transport sector, for heating and certain industrial processes. The world had bet heavily on the electrification of the transport sector and batteries were becoming cheaper and more reliable all the time. But they were quite useless for shipping, flying and trucking and did hardly dent the carbon footprint of private traffic due to their outlay from production, which would only allow them to save very few TGGEs and that only a decade after production. The fact that people still loved big cars just increased this problem. Big cars meant big batteries and a big carbon footprint. Battery prices also became less cheap than should have been expected as the rapid increase in their usage led to supply constraints not easily overcome. And with growth in emerging countries still being driven by vast construction projects, the production of concrete and steel did not abate either.

All in all a constant progress towards carbon reduction in production and transport happened, but it was driven by efficiency gains more than by system changing technological breakthroughs and no big push for, for example, an integrated system of solar or wind power with carbon capture

and synthetic fuel production that was urgently needed. This happened on a small scale proving the technological feasibility, but as long as policies did not change, market structures remained the same, not driving fossil fuels out of the market quickly enough, despite slowly increasing carbon prices. The carbon price after all was not set according to the true costs of the emissions but by the needs of industry so as not to harm employment. The economic costs of the Corona pandemic meant that for many years politicians focus was on the growth of economies no matter what. And education also lagged behind, as a new curriculum needed years to develop, which meant that while scientific consensus was a few years behind the real developments, climate education lagged another several years behind. Mankind`s systems simply could not keep up with the rapidity of events it had triggered.

Yet at least the pressure for action was constantly increasing and man-made emissions finally leveled off before starting to slowly sink at the end of the decade as mentioned before. Yet it was not more than a single digits reduction and therefore far below the original aims of the Paris treaty of 2015 and did not include the negative net emissions of forests and soils succumbing to the heat and drought. This did not happen every year to the same extent, but surpassed 25% of human emissions by the end of the decade in a very bad year, therefore leading to an overall increase of net emissions up to 2030. Considering that emissions from natural sources were not counted in a countries footprint and TGGEs still not calculated, so that for example an imported good had a carbon footprint of zero, accounting tricks seemed to imply a rosier picture. But even with the best accounting trick no major country fulfilled its own promises from 2015, so

greenwashing became the norm. Carbon credits were traded and trees were planted in masses to offset countries and companies carbon footprints, but in monocultures and without making sure saplings would survive and prosper. Those trees, if they prospered at all, would have needed decades to store the calculated amount of carbon, but for greenwashing that did not matter. The amount was written off immediately.

On the other hand pretending that reforestation or even better protecting existing forests did not have a positive impact would be a lie.

Intriguingly an ever increasing - albeit far too small - number of individuals started to tackle their carbon footprint individually by adapting a carbon free life style, a **zero carbon life**, exactly with the idea in mind that carbon was part of a cycle and if you could not reduce your emissions to zero by stopping to breath at least you could balance them by making sure more carbon was sucked out of the atmosphere than without your actions. This was the only way that the laws of physics offered at that time in a system still mainly driven by fossil fuels and wasteful agriculture. These trendsetters lowered their emissions as far as they could, or at least were ready to, and then compensated for the rest by paying for it to be sucked out if the atmosphere by organizations that had to prove that they did what they promised without hurting the local population. Because carbon capture with plants done right functions very well as we know. There was just not enough to go around for big emitters like companies or countries to pay for as land for planting trees or restoring moors was still scarce during most of the century. Hence the greenwashing which could flourish as no oversight was established by an independent watchdog. Another failure of this decade.

2030ies :

The decade in which everything quickened: temperature increase, the frequency of disasters, the collapse of ecosystems, the number of species that died out and the rate at which ice and permafrost melted. But also the speed at which vast numbers of regenerative energy projects were started, the increased intensity of research from basic science up to all kinds of technology from carbon capture to SRM to the collection of genetic material from species on the brink of extinction.

This after all was the decade in which the 1.5°C benchmark mankind had set itself - however arbitrarily - was surpassed. With temperatures varying from year to year due to natural variations it is not easy to pinpoint such an event 100% correctly. But whereas temperature spikes from El Nino years had only temporarily crossed it twice, most calculations agreed on 2035 as the official year, despite the fact that 2036 was slightly below that mark again.

And while such arbitrary benchmarks do not mean much to the earth`s climate in general - for it the continuous overall trend of heating up was far more important - it proved a catalyst for people`s fears and therefore also for sudden political activity. For while the climate crisis was a slow grinding event in comparison to a sudden rampant virus that triggers a pandemic, human reaction is similar once the threat has become clear. Both problems are underrated at first, losing precious time, before action sets in at an unprecedented speed, showing mankind`s adaptability, but also leading to fear driven overreaction.

Some truly positive developments had already started in the preceding years, especially with respect to education and reporting. **Climate change** as a name was replaced by **climate crisis** or at the end of the decade mostly by **climate collapse**, representing what was rightly feared. And climate change did not go into the dust bin of history alone, but together with the ever dwindling number of climate change deniers. This was probably mostly due to their increasing age and therefore increased mortality, as people who do not "believe" in science can never be convinced by facts as the flat earth movement had proved beyond doubt. But as most climate change deniers had left the levers of powers from countries to companies new climate friendly policies were introduced at an ever increasing rate.

Teach Climate! was a case in point. This movement began in the 2020ies and became a global endeavor, ensuring that geosciences, esp. climate science played a major role in education from elementary level upwards all over the globe.

And as ever more people and companies tried to live and produce carbon free **green carbon capture** matured into a major business that became well regulated, ending the area of green washing by collecting vast amounts of data. The huge sums involved allowed to pay for vast ecosystem preservation and rewilding projects, especially in the tropics, with some rainforests for the first time in centuries growing in size now that they had a value if the trees but grew. It also meant that TGGEs had to be collected systematically to avoid accounting tricks so common for greenwashing, for the first time leading to enough information to truly see where emissions were produced and how much of them. This led to fairer

prices and influenced national carbon taxes which started to be charged for all TGGEs and by the end of the decade formed the basis for a globally tradeable price set by how much it took to get carbon out of the atmosphere. Yet this was then only a venture driven by individuals, companies and some countries, not a globally agreed on standard that was binding for everyone. It would take another few years before in the 2040ies it evolved into the global system underlying all carbon capture and storage measures.

Another positive aspect of carbon taxes and TGGE-calculation was that any strategy to lower a carbon footprint had, for the first time, to be based on maximum reduction per money invested and not on policy whims. That meant market mechanisms could finally start to work properly and as carbon taxes went on upwards a massive change in how energy and goods were produced set in, helped along by ever more regulations and laws.

The big nasty surprise for many investors was not that the coal and oil industries lost market share, but how fast that happened in the energy sector and that new exploration basically vanished due to an extreme lack of financing, first for expensive areas like in the Arctic or deep sea, but at the end of the decade nearly universally. Coal consumption had already started to crash under a triple attack from cheaper renewables, rising carbon prices and emissions regulation from CO2 to particulate matter to mercury when the drastic action to cut emissions from 2035 onwards meant that no coal fired energy plant was allowed to be run without carbon capture beyond 2040 in nearly all countries world wide. But because only few of those CCS-projects proved viable in the long run only the steel industry remained as a major consumer of coal driving prices down

dramatically which lead to the closure of most mines. As the steel industry was forced into a dramatic technology shift in the 2040ies the final result was **the end of coal** that had started the industrial revolution as a source of energy by 2050.

Oil demand continued to slow due to the electrification of personal transport governments had pushed since the last years of the 2010s and the increasing carbon prices and the growing number of people trying to reduce their carbon footprint. But this gradual decline went into overdrive when most governments - and not just a few trendsetters mostly in Europe - restricted mobility based on fossil fuels to reduce carbon emissions. Short haul flights were forbidden, fuel prices raised dramatically and in some places even the use of cars was restricted. Naturally due to lack of demand oil prices took a dramatic nosedive, with the major difference to former oil price collapses being that it was abundantly clear that this one would last for decades, if not forever and no one was ready to bet on oil having a future as a source of energy anymore. Expensive projects hit the wall first: oil production from tar sand in Canada ended with a bang in 2038; most fracking simply was wound down before 2040 and deep sea projects followed suit. Oil production in the Arctic had already declined dramatically as a result of ever higher costs amid rapidly melting permafrost and eroding coast lines and emptying deposits as no one had been ready to spend vast sums of money to explore expensive new projects considering the climate and investment risks. The dreams of Arctic riches had always been pipe dreams but officially they were only ditched in the 2030ies as dreams die but slowly, whatever the facts.

Meanwhile the collapse of the Arctic and Antarctic ecosystems went on unabated, proving them to be the Achille`s heel of the world`s climate where several feedback loops - from vanishing sea ice to melting permafrost to dying boreal forests to receding glaciers and ice sheets - amplified each other to an extent that the agreed on term for this process came to be known as Arctic (or Western Antarctic) Collapse.
With the world starting to panic after realizing that 20 years of climate policies under the Paris accord had failed and that green carbon storage was reaching its limits due to lack of space and climate dangers (only a growing forest can store carbon after all) former mental restrictions lost their grip over climate stability research and policies. **The argument had always been that it was wrong to use technology to control the climate and that a change of habits and economy was the way to go.** Why exactly is something we do not understand anymore, but it was probably based on the fact that those at the forefront of climate activism were also people who were skeptical of technology (and capitalism and market economics) in general, turning a life or death question like climate stability into a question about morals, aka good and bad behavior. But - as had been predicted by science for decades - such a limited approach, especially considering that a large part of the human population did not go along with the idea of drastic emission reductions and the concomitant economic upheaval threatening their wealth or their aspirations for wealth, had proved insufficient to stop the world from heating up. And with rising emissions from natural sources (dying forests, reefs, melting permafrost, etc.) many people were ready to be more creative and test different ways to store carbon or cool the climate, from seeding oceans to create an algae

bloom to capture massive amounts of carbon to technology to capture it from industrial processes (CCS at coal plants) to direct capture from the air to local cooling measures in cities (greening) and mountains (whitening) and the first larger scale SRM trials in the USA, China, India and Australia.

But except for CCS in various industries, direct air capture plants to produce synthetic fuel and local green cooling measures that had become standard in many cities all of the other technologies were not advanced enough or especially scaled up enough to be of much use during this decade. Decades of dithering had a cost after all with all those ideas never really tried out on any remotely appropriate scale the idea of stabilizing the climate was a haphazard and chaotic affair without any technological help ready for use now that the need had finally become clear with inexorably climbing temperatures and the feared 2° limit approaching within a decade. This was the start of what came to be known as the **"Fever Period"** and a clear dark red status on our **Global Heat Index** (only invented 10 years later).

2040s

The decade that changed our future

Several major upheavals changed the track of the world economy on to a new growth path that led to long term prosperity.

1. SUNSYNC

Right at the beginning, in 2040, the biggest and most daring system changing project of a country turned the United Arab Emirates - with Qatar fast on their heels - into the first carbon neutral fuel producer (SUN-SYNC). Seeing the mortal danger to their old model of relying on large scale oil and gas production in a world that would soon out of necessity abandon oil as a source of energy they had begun to start a massive investment in solar power and the direct capture of carbon from the atmosphere. In a first stage in the 2020ies huge solar power plants based on the abundant space and sun were built that in the 2030ies started the synthetic fuel revolution for aviation and was later used to store carbon in huge quantities in former oil and gas deposits. Based on cheap energy and the export of synthetic fuel and fees for sucking carbon out of the atmosphere and storing it underground this proved a sensible long term strategy soon emulated by their Arabian neighbors. Once the merits of this strategy had been proven the United Arab Emirates became the first major carbon free country in 2040, ten years ahead of the world, switching from one of the biggest carbon footprints to a nonexistent one of zero. The Arab countries did not stop producing oil as they had the cheapest production costs globally, but most of the rest was used for the chemical industry, just like today. Oil as a source of energy ended in 2050 when shrinking

demand and competition from electricity and synthetic fuel together with high prices from carbon taxes meant it was driven out of the market rapidly even before in 2050 the world banned it from being burned.
This green energy revolution lastly enabled the survival of the airline industry which under the double pressure of restrictions and high fuel prices due to ever rising carbon taxes was under mortal threat. But with Ethiad and Emirates offering the first few carbon free flights at the beginning of the 2030ies they started to set a new course that also enabled the tourism industry in the United Arab Emirates to survive. As a result the UAE industrial policy of the 2020ies and 30ies created a heavy profit and secured the long term prosperity and stability of the country turning it into the role model for their neighbors from Morocco to Pakistan, but also Australia and Namibia and other countries in the desert belt with a coast line who had water and sun in abundance and became the synthetic fuel producers or, like Morocco when located near a major market like Europe, electricity producers. With enough water from desalination plants powered by the same cheap solar power this was the beginning of the Arab Renaissance, which turned the whole Arab world into one of the richest and most modern places in the second half of the 21st century, reducing population growth and poverty and instability in its wake.

2. Global Cooling

Global cooling measures had long been feared as too easy a "solution" to reign in the rising temperatures for moral reasons but also because of the potential side effects and the troubles of coordinating it on a global level. But the "moral" argument quickly went into the dustbin of history when -

what should have been known for at least three decades - the need arose to stop the climate from collapsing. Rather the moral question was turned on its head, for who could argue that a critically obese patient in obvious danger of imminent heart attack or stroke should forgo a life saving operation or medicine because it would have side effects and instead save his life by calorie restriction alone, however remote the chance of the success such a strategy offered. After all it was the fever, the high global temperatures, that killed ice and ecosystems and not the carbon itself, except for the acidification of the oceans, which was a problem on a far smaller scale.

This means global cooling always had the potential of saving the planet from overheating - as we know to well - and the questions of side effects should have been prepared for by more than just modeling on computers. But the world had procrastinated in the hope that renewable energy and behavior change would save the day, not comprehending the time scale of the task because of TGGE`s interest and the limits too how much human behavior could influence the outcome, while tipping points were passed and nature had started to heat up the globe by itself, making clear that humans once they had triggered a global heating event (2010s) could only stop it with drastic measures.

With basically no testing in the 2020ies the second part of the 2030ies saw uncoordinated action once panic had set in, but due to technological limits not on a scale that could trigger a global conflict. It had always been clear that once people felt threatened they would push for a "miracle" cure, especially now that it was presented as global cooling and not as Solar Radiation Management, an appropriate scientific name but far too scary to

grab the public`s imagination as a helpful technolgogy, therefore **postponing its use by one or two decades, causing temperatures to rise far beyond what would have been necessary**. And to make that plain for my readers, to clarify the situation so confusing to anyone from the 22nd century for whom climate control is a fact of life, this was a sudden change in the course of only one or two years, turning a pariah technology into a savior, the "miracle" cure, as up to the 2030ies mankind had willfully ignored coming up with any climate stability program that would have included cooling measures, and if only once other measures had failed to keep us below the 1.5° mark, and test and prepare such a scenario appropriately. Not doing so was comparable to knowing the genetic makeup of the virus the will cause the next pandemic, but not developing a vaccine based on that knowledge.

At least the world could follow a script on how to cool the planet without causing too many side effects with regard to rain and wind patterns by following the **global cooling protocol** proposed in the first climate stability program decades earlier.

But being late mankind could not follow the original idea of starting very gradually and thereby avoiding side effects while learning to understand the repercussions of cooling certain areas by certain degrees, by testing procedures while already slowing the increase in global temperatures slightly and then cooling strongly enough once the 1.5° were reached to keep it from rising further.

In 2040 temperatures had passed 1.7° and the 2° absolute upper limit mankind had set itself was predicted to be breached during that decade with certainty. The public, not understanding the risks of an untested

technology and the dangers of fast temperature movements up or down, wanted drastic cooling back to get below at least 1° by 2050. Some even argued for returning to the 0° set point before the industrial revolution to keep the ice world from melting disregarding the fact that such a world was too cold for comfort in many places globally. (This was the beginning of the hard fought discussion about the best average global temperature.) But like the old saying goes: **the dose makes the poison**, medicine that can cure has the potential too harm especially if used too much too fast and then not long enough because it caused some kind of pain. **After all a miracle cure would be a cure that functions without any respect to the laws of cause and effect. No such cure existed for the planet`s fever, none could exist.**

Luckily, though, one very important piece of advice from the original global cooling protocol gained traction at the beginning of the 2040ies, namely that any global cooling measure had to be a coordinated long term endeavor, that due to its nature - long term means many decades after all, or in this case all the way into the 22nd century - should be taken out of the hands of politicians ruled by short term political cycles and prone to lobbying, by establishing the **Global Climate Stability Governance Body (GCSGB),** inspired by the world`s independent central banks to guarantee a stable climate like the banks had guaranteed a stable financial system. After a few years - beginning as mentioned above at the end of the 2030ies - of countries trying to run there own show to limited success (lack of ready technology can be a real drawback and a global problem is har to be solved locally) it was set up on 21. October 2042 after only a few months of preparatory discussions as time was running out. The pressure from

scientists and smaller countries had forced the politicians of the main countries to come to **the most important conclusion of all in the last two hundred years: To give up power to a global body (of experts) for the greater good of the whole planet!** Russia, as will be explained later, had anyhow decided that its future prosperity depended on it, hoping - correctly - to profit from it.

As a result the world for the first time followed a comprehensive strategy that was based on the three pillars of 1. reductions and 2. negative emissions to bring the greenhouse gas concentration in the atmosphere back to its pre-industrial levels by 2120 and to meanwhile 3. cool down the world back to an average of 0.3° as fast as possible without serious side effects.

A very important aspect overlooked too long was that to do so natural variations had to be counterbalanced, as some places like especially the Arctic heated up especially fast due to all the feedback loops of melting ice and dying forests, to name just two prominent examples. So instead of cooling above an individual country, which had clear limits in an interconnected atmosphere, or only cooling the stratosphere above the tropics from where the wind would spread the reflective particles responsible for the cooling, inspired by what volcanoes had shown us was possible, it was necessary to cool the Arctic and Western Antarctica at a far higher intensity. Otherwise the temperature differences would actually decrease between the equator and the poles, despite the planet officially having become colder again, wreaking havoc on essential wind systems like the jet streams. Only by cooling down the polar regions - were side effects on human endeavors were far more limited than in the tropics or

temperate areas as nobody (a few thousand Inuit, Norwegians and Russians apart, a risible number if compared to the 10 billion globally in the second half of the 21st century) lived or farmed there - could **tipping points already passed** by then, from sea ice, to permafrost and boreal forests, **be reset** and turned back, with the additional advantage of slowing polar ice sheets from melting ever faster.

Therefore the GCSGB developed a plan by which countries like Russia who used their planes and drones to cool the Arctic were paid to do so, just as all the carbon taxes and voluntary payments to offset carbon came under one roof, calculated on the basis of current costs for getting enough carbon out (the highest one per cent setting the price) to finance enough carbon capture to achieve the 2120 goal of lowering carbon levels in the atmosphere back to pre-industrial levels.

Unluckily for mankind and its good intentions the ability to cool down polar areas was rather restricted due to lack of technology and especially infrastructure, which meant that not much progress was achieved in this case before 2050.

Gentle cooling of the tropics proved much easier and therefore more successful, but even there years went by before mankind had the ability to pump enough particles into the stratosphere to stop global temperatures from rising further. In the end the 2°C limit was not breached more than once in 2048, during an especially hot year due to natural cycles, and the decade ended at 1.9° on average for the last three years.

Establishing the GCSGB was essential as demands for a faster cooling effort rose with the public not understanding that temperatures that had risen over many decades could not be lowered back quickly without

further damaging ecosystems. But with climate disasters striking everywhere patience was low, leading to political unrest, proving the value of an independent GCSGB, not concerned about short term pressures but long term climate stability.

3. The Siberian Project (later copied by the Canadian North and Alaska Projects)

Russia had been running out of income from its dwindling fossil fuel exports in the 2030ies and was hit by major disasters from droughts in its southern grain belt to vast fires in its endless boreal forests and collapsing infrastructure in Siberia and the north were permafrost melting turned soil into mud, all together causing an economic crisis that hit the aging country hard. Instead of profiting from a warmer world as they had believed they would they had lost their main income (oil and gas exports), had to live with higher costs for staples like bread due to failed harvests and a vast periphery hit hard by disasters (fires) and ever harder to reach (mud), driving up costs for most mining ventures (closures) and as a result losing most of its population (migration). Together wit a naturally necessary change in the presidency, as even the longest living rulers run out of health, this was accompanied and resulted in political turmoil.

So all of a sudden around 2040 Russia therefore changed its policies, trying to find new means of income and ways of cooling the Arctic to finally stop its vast Arctic territories from burning and melting. At that time Russia actually had the worst total (natural + man made) carbon foot print of all nations due to its vast permafrost areas belching out methane

and CO2 while melting and boreal forests dying or burning for lack of water.

They duly started the Siberian project based on carbon capture and storage in the old oil and gas deposits powered by wind along the Arctic coast paid for by the global carbon storage market and from 2043 coordinated by the GCSGB like all other such projects. The true twist, though, were the two game changers. The first was that they started tests in 2040 on how to cool the Arctic by cooling the Stratosphere above it hoping that the world would pay for it. The second was the idea of turning the whole of Siberia and the European Russian Arctic into an ER (ecosystem restoration) park as that meant locals would be paid to assist nature`s recovery making it much more valid for them than a rewilding scheme like a national park. Again the Russians argued that if they delivered such a service the world had to pay for it. This became the world`s largest ER park ever even after the countries of the Amazon Basin repacked their individual projects into a single one in 2052.

4. A changing world economy

The drastic restrictions and new laws that began to be implemented in the 2030ies brought along a dramatic fast forward switch in energy production to renewables and only renewables, ending fossil fuels role by 2050. Mobility - and therefore trade - had become more expensive, which together with carbon taxes and huge investments in mitigation schemes (floodwalls, dikes, fire fighting and especially infrastructure and village relocation and replacement) drove up inflation. The global economy was in upheaval with the third agricultural revolution gaining speed as animal products (from real animals) finally fell out of favor hard as the easiest

way of doing something for the climate and animal welfare, shattering old farming practices globally. That such a situation did not escalate out of control despite the many shocks was due to the fact that alternatives were: zero! Populist policies had run their course in the 2010s and 2020ies showing that big promises were no substitute for understanding and that you could not wish away problems determined by the laws of nature and a better informed public (geoscience education and quality reporting, drastic action against fake news and a lack of dictators to finance them) together with strong and honest leadership, as quite a few politicians rose to the challenge, helped to steady nerves and keep course. Alternative income strategies for rural areas were developed and tried out, paying farmers for storing carbon in their soils and for protecting an ecologically valuable countryside (a service to the public after all and the opposite of the chemically sterilized land of industrialized farming ventures) and the ER projects that had started to pop up in the 2030ies when they were financed from carbon compensation schemes.

2050 to 2100

A decade of progress in cooling technology and infrastructure enabled controlled cooling in the Tropics and full tilt Arctic cooling in the 2050s and in Western Antarctica in the 2060ies. Drones became the standard bearers of that effort, far cheaper than planes and more precise than all other alternatives, spraying particles and collecting data at the same time, moving with the zenith of the sun, working in the tropics in March to May/ September to November and in the Arctic from June to August and Antarctica from December to February. That kept costs down and proved

sufficient for polar regions as they only had to be really cooled in summer as springtime saw ice and snow cover and therefore ground level albedo driven reflection at a maximum while winter half-years (in the Arctic 21.9 to 21.3) were mostly dark polar nights that could not be cooled by reflecting sunlight anyhow. It also limited feared effects on the ozone layer as the yearly occuring phenomenon of ozone layer thinning above Antartica, nick named ozone hole, was restricted to spring (September to November in that case) while cooling efforts only started afterwards. (It has to be added here that cooling the troposphere of the polar regions led to temperature increases in the stratosphere above which actually reduced ozone depletion in the polar regions while ozone losses in the rest of the atmosphere were on a much smaller scale and of no real consequence.) Average global temperatures fell below 1.5° in 2058 and to 1° in 2068 (0.5° per decade being considered the fastest innocuous cooling and even that only if half that cooling took place in the polar regions alone) as particle cooling in the stratosphere proved less damaging than feared if done responsibly and due to further action from SRM measures on ground level, especially in cities (greening+albedo increasing) and on glaciers (whitening) to reduce local temperatures, and increased cloud brightening. All elements were coordinated by the GCSGB to form an integrated global cooling strategy.

Technological advances (solar power and synthetic fuel foremost) and the fact that burning fossil fuels had come to an end meant that almost all greenhouse gas emissions were due to natural processes from melting permafrost to burning or decaying plants. But with green carbon capture based on ecosystem preservation and restoration and algae seeding and

industrial scale carbon capture really taking off in the 2050ies the planet achieved true net zero emissions of CO2 in 2052 or 2055 (scientific opinion differs as there was still not enough data on natural emissions to be absolutely certain) and at least from the 2060ies onwards clearly negative emissions lowering CO2 concentration back to 350ppm by the end of the century. Methane levels went down far faster after ruminant farming collapsed and due to methane reduced rice production (no long term flooding of rice paddies). The same was true for N2O levels with the end of nitrogen fertilizer use.

Ecosystem restoration and rewilding started full scale with green carbon capture financing huge efforts to keep tropical rainforests, boreal forests and mangroves - to name just the most important ones - alive and individual countries trying to restore their coral reefs, following the path of Australia. Australia had pioneered a comprehensive restoration process were all threats to reefs were tackled: runoff management and watershed restoration together with a ban of artificial fertilizer in the hinterland, heat resistant coral breeding, destructive species control and ocean current driven deacidification programs gave the Great Barrier Reef a fighting chance until global air temperatures had come down far enough in the 2060ies and - more important - sea temperatures came down far enough at the end of the 22nd century.

Agriculture changed quickly from industrial farming to one based on carbon capture and ecosystem protection, not unlike the principals pioneered by organic farming during the last hundred years, driven by carbon pricing, regulation and now ever more quickly the replacement of livestock by plant based products or cultivated meat, fish and eggs.

Producing enough food for 10 billion people proved no problem once the incredibly wasteful production of animal products was gone and because the obesity crisis of the first half of the century had led to better education, regulation (preventive health, severe marketing restrictions) and control (technology) limiting calorie intake to what was actually needed, which alone reduced the necessary amount of food by 25% per person (33% was the potential but people still ate a bit more than necessary) until the end of the century.

Decreasing land use for farming animals freed vast tracts of the planet over the course of those 50 years until at the end of the century no animal farming was left and no slaughterhouses. The exception were traditional types of animal husbandry used to keep landscapes and their ecosystems alive that human endeavor had created over centuries, were the farmers were paid to grass their sheep and cows to keep for example transhumance meadows from being lost.

With green carbon capture and ecosystem restoration becoming big business indigenous and local communities in remote corners of the planet found a new role and income as stewards or guardians of vast wilderness areas, reducing economic discrepancies between urban and rural areas, center and periphery.

Richer places like Switzerland and Austria even pioneered glacier restoration in the Alps. For whereas all glaciers on the planet outside Antarctica - the biggest endeavor, still running after more than 140 years, is the **Greenland Brightening Project** (GBP), spearheaded by Denmark - were now sprayed with a reflective layer to enhance their reflectivity with the help of drones, brightening especially areas of black ice and snow were

soot from forest fires increased melting processes, the Alpine countries used there knowledge gained from creating artificial snow to regrow their glaciers.

The one problem that could be only slowed but not stopped was sea-level rise. Cooling the Arctic and the Western Antarctic peninsula was not only meant to re-balance global temperatures by increasing the temperature differences between the tropics and polar regions that drove global wind and ocean currents, but mostly to make sure that the ice worlds would not melt and collapse, heating up the planet and driving up sea levels. Temperature sensitive sea ice cover was quickly returned to acceptable levels and lastly to levels last seen in the first half of the 19th century which helped to restore the Arctic`s extremely threatened ecosystem. Polar bears at least seem to be rather happy again. Permafrost proved a bit harder to cool as some of it was located far south of the Arctic circle above which most cooling took place but the increasing sea ice cover helped lower average temperatures fast, so that together with local endeavors that made use of cold continental winters by grazing former forest areas and turning them into arctic steppe, permafrost deterioration was lastly stopped. The remaining boreal forest could be kept alive due to fewer bark beetles and droughts and the underlying peat soils were restored.
By the end of the century three major feed back loops had therefore been tipped back from a vicious circle of heating up the Arctic ever more into a virtuous circle of cooling it down more and more. But ice sheets went on melting, albeit at a slightly slowed down rate. The problem here was a delayed temperature sensitivity. It was not so much the temperature itself

that drove their melting processes, but the fact that they were sliding towards the much warmer sea level, were big chunks broke off and drifted away while slowly melting.

And although this process could be dramatically reduced as due to colder air temperatures and the increased reflectivity of brightened ice and snow less water melted which functioned as a lubricant speeding up the sliding process below the ice. This proved - together with the recovering sea ice and the corresponding reduction in sea water temperatures that had melted Antarctic shelf ice from below - enough to keep the main part of Antartica`s giant ice sheet from breaking apart and together with measures undertaken in Greenland and other smaller glaciers this century, like the filling in of glacial mills - like a dentist fighting cavities - and even damming efforts to stop ice from sliding downhill, basically stopped melting processes in Greenland and the Arctic this century.

But Arctic and Antarctic cooling measures set in too late (at least 30 years too late is the common consensus now) to stop massive amounts of ice from melting, especially in Western Antartica, where due to the special topography shelf ice had functioned like a cork or stopper keeping the ice sheet from sliding. With those shelf ice stoppers having been gone too far by the 2050ies 3/4 of the ice shield had become instable. And although atmospheric cooling and sea ice recovery slowed the process it could not and still has not been stopped. So if you ever wondered, why despite our best efforts, we have been unable to stop sea level rises (about 1.5 meters above pre-industrial levles) despite the fact that now after 150 years sea water temperatures and their concomitant expansion (sea water level rise)

have been reversed, than this is the reason. Sliding ice masses are hard to stop.

As a result we have lost precious islands and coastal areas and have spent trillions of dollars on sea level rise mitigation, only because rapid heating in Antartica was not brought under control. First, because emissions went on unabated despite our clear understanding of results and then because despite the tipping point having been passed - scientists proclaimed that the tipping point for the Western Antarctic Ice Sheet was passed in 2014 - nobody considered cooling it to stop it further deterioration. Had they started in the 2020ies 1/2 a meter of sea level rise could have been forestalled in Western Antarctica alone for a comparatively tiny amount of money.

Now we are fighting with dams and even mesh net constructions to keep the ice sheet from collapsing and increasing sea levels by another few meters, too much for most coastlines to be acceptable. But with the colder Antarctic temperatures having - naturally - reduced snowfall we can not wait for glaciers to recover in a colder environment and measures for glacier restoration, like in the Alps, are unfeasible in Antarctica on such a scale.

Other climate driven disasters did also go on in the second half of the 21st century because of the massive amounts of energy stored in the oceans as cooling the atmosphere did take many many decades, as we now know, to bring the water temperatures back down. Therefore atypical circulations like El Nino still wreaked havoc with droughts and floods, tropical cyclones hit hard both taking part of the excessive heat stored in the water

back to the humans who had caused that increase. And while richer countries at least managed to build infrastructure that reduced the impact of such disasters many people in poorer countries, especially along the inundated, but still crowded coastlines lost their lives.

So while mankind managed to lower average air temperatures and greenhouse gas levels to "normal" levels due to the **time lag** produced by the energy stored in oceans and the sliding ice sheets the worst of the feared climate induced disasters raged on for decades.
Only the fact that this necessitated ongoing global cooperation - for so long that old ingrained egotism largely vanished in the dustbin of history - at least meant there was an optimistic outlook for the future.

22nd century

The most prosperous and peaceful century in mankind`s history. Several trends coincided to achieve this extraordinary outcome. The most important one has already been mentioned before as the increasing global cooperation while fighting the climate crisis and the global institutions established to do so led to a global government structure not unlike the EU in the 21st century, the role model for this development, just on a global level, where old enmities had been overcome. Just like the plague killed of the feudal system at the end of the middle ages, leading up to the renaissance and the age of reason, did the global climate crisis sound the death knell for centuries of warring nation states. This did not create a perfect world, but together with technological advances based on abundant cheap solar power, healthy food and an economic system fixed on minimized waste and a circular economy the world did not only not run

out of resources and food. We finally managed to spread wealth globally. One important aspect was that with nature having a value, keeping nature humming along had become an essential service even after the money from carbon offsetting and storage schemes had dried out once greenhouse gas levels were under control. This meant that the losers of former times, the rural and especially the remote places, had found a stable source of income. And with services from ecosystem restoration to wellness and education dominating the economy economic crisis became far less severe than in earlier centuries. And with fewer losers and a juster and far older and therefore naturally more peaceful society there were fewer conflicts and naturally no wars. The peace dividend easily paid for the ecosystem restoration efforts that spread wealth globally and created an abundance of jobs despite robots and computers doing the hard parts nowadays, lowering working days to 4 per week and 6 hours per day.

Most important though, the climate is stable and will remain so for the foreseeable future. To ensure that the original plan to lower total greenhouse gas levels back to their pre-industrial state was given up because it would be much harder too quickly pump out more greenhouse gases to warm the planet should sudden events like a major volcanic eruption or the solar cycle cool down the planet below our range of tolerance. SRM management responds much more quickly to such needs, as it has only a very brief time lap.
Major disasters, so far less common now that the oceans have cooled down again, are mitigated by local measures like drastic cooling of water surface temperatures in the path of a massive hurricane.

It should not surprise anyone that once we had to learn to keep climate stable we would apply this knowledge not only on a global level, but already on a regional level to keep cyclones, droughts and floods at bay. The discussion we face now is how far mankind is ready to fine tune its efforts to control not just climate but weather, but the consensus accepted for now - and we do have to admit that technology would have to progress dramatically for weather control - is that we should leave the weather alone, and only mitigate extreme, once in a century events that would cause too much destruction and death. And we have already found out that if you suppress weather patterns like hurricanes too often instability in the system only increases. So the right conclusion at the moment is that 99.99% of all weather events are acceptable as long as the basic climate fundamentals are under control. **We do not want to control the weather or the wilderness once we have helped to restore it after all, but leave the planet in a healthy and natural state.** This is after all the state mankind evolved to live in.
And that is just what we have achieved in most respects. This planet is brimming with life, and we, as mankind, live richer and healthier and longer lives for it, with pure water, air and soil and waste - especially man-made chemicals - recycled and reused to keep it out of nature and human bodies.

Considering how despondent the world was in the 21st century this just proves - again - that mankind can overcome challenges by cooperation and with ingenuity and determination. Hope and realism were running too low and actually hindered a concerted rescue effort, as people who have no

hope do nothing but wait and sit for disaster to strike and only then, driven by fear and pain, get active. Still, why it was necessary to do so only after we reached the brink of the abyss in the 2040ies is beyond our understanding now, despite all the factors listed at the beginning. Only the vicious combination of all these factors together can explain it - a bit - but never excuse the massive destructions that all ecosystems had to endure.

Let us hope we will learn from history and wake up earlier next time a major disaster looms instead of sleep-walking the only planet we have into a mass extinction event of our own making.

Had we lived in the 2020ies, what strategies should have been priorities?

A. Strategies that are politically easy to start:

- **The most important one: save species**, with **anti-extinction measures** from saving their whole habitat (protected areas) to specific ones like paying farmers to protect meadow birds and poor countries to upgrade their anti-poaching forces as any species that had not died out could be nurtured back from the brink of extinction. A last ditch effort is collecting as much genetic material of species that died out as possible to bring them back decades later when they have a chance to survive again.
- establishing a (global) **codex for carbon compensation schemes** and a control routine to avoid greenwashing, especially because it is giving a

good idea a bad name, and because such an international cooperation can lay the foundation for an honest calculation of all TGGEs and the establishment of a **Global Climate Stability Governance Body**

- investing in - instead of ignoring - the key technologies of the climate fight in order to be able to roll them out on industrial scale in the 2030ies: renewable energies and intelligent electricity networks, carbon capture and synthetic fuel production, cheap batteries unrestricted by resource scarcity
- invest in local cooling measures from greening cities to whitening black snow and ice and the area around rapidly melting glaciers (**local SRM**)
- develop a detailed plan for cooling the planet - and especially the polar regions - in the 2030ies in case the political dynamic shifts rapidly to avoid panic driven overreactions (just like for a pandemic, a systematic plan of action has to be ready): G**lobal Cooling Protocol**
- drastically **improving curriculums** from elementary schools to universities to improve general knowledge about geosciences

B. strategies that are essential but can run into opposition from established interests:

- establish a **future proof agricultural structure** that nurtures nature and guarantees farmers` incomes by paying farmers for the service of species protection and carbon capture and creates a 20 year exit plan from industrial scale factory farming
- include all TGGEs into carbon prices or taxes and make sure that their gradual increase will drive carbon polluters without carbon capture systems out of business at the beginning of the 2030ies

- test cooling and carbon capture measures that have a high probability of becoming essential in the fight for a stable climate:
  stratospheric SRM in the tropics and Arctic (e.g. Svalbard), algae blooming

C. Individual action:

- The most import thing any individual can do is to protect wildlife and ecosystems by sourcing (buy or grow) **organic food** as this protects vulnerable species (insects, birds, soil dwellers) and **reduce consumption of meat**, but also of **fish** to reduce pressure on the ocean ecosystem (the supposed health benefits of fat fish, which is often full of mercury, lead and so on, can be gained by eating omega three rich algae oil, sourcing protein from legumes, selen from coconuts and iodine from iodine enriched salt --> there is no need to eat fish for supposed health reasons)
- Additionally individuals can - and should - reduce their own carbon footprint by lifestyle adaptation and compensate for the rest of their TGGEs, helping to establish a system of **green carbon capture** (the idea behind **zero carbon life**)
- put on political pressure for TGGEs and therefore true emission pricing

Put together that means that it is more important to help **create the structures that will ensure nature`s survival** (a. organic farming and a diet with fewer animal products/ b. carbon capture) than to frantically try to drive your own carbon footprint to zero by reductions alone, which is physically impossible anyhow. Buying electric cars with an enormous

carbon outlay during production is no solution by itself, but it can also help reduce the importance and influence of fossil fuels. Boycotting whole industries like flying without considering their value on an individual basis is wrong, too, but a system that includes its real costs is necessary to drive out short haul low cost flights that could be easily replaced. Fair carbon prices and regulation can achieve that if political action as a result of public pressure happens

We need new structures and technology to stabilize the climate and nurture nature, not extreme attitudes that would ban planes or cars generally and that a vast majority of people rejects or - even if they understand the problem and the necessity of the countermeasures like in the Corona Crisis - only goes along for a limited time before ever bigger numbers revolt against them. Remember that the goal is a stable climate and healthy ecosystems, not a certain lifestyle or economic system. We have to focus on the real goal. Better, healthier lifestyles and fairer societies are well worth fighting for, but as an add on and not as the main goal. Climate collapse, even if only regional like in the Arctic, is far too dangerous and has to be the absolute focus of all our endeavors.

Too be continued!