A greater understanding of the change in global weather warming and the effects on architectural detailing, material choice and human interaction

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A change to adoptive architecture – A review paper

The evidence is there, wildfires, high temperatures, high volume rain falls, large areas of the Arctic and its permafrost and ice almost nonexistent, and glaciers practically gone, the planet is warming. Global warming is here, can we do anything about it, before the so-called 'Tipping Point' comes into effect and the knock-on where events caused by the primary cause takes over if they have not already done so?

To be able to understand the complex relationship of all the causes, and there is no longer one, there are many, a comprehensive and relatively high understanding of the problem and related contributors is not just desirable, but essential.

CO2 or carbon dioxide is seen as the leading driver of climate change, and there is a lot of work that is being done to reduce carbon from the atmosphere. But whilst carbon content is seen as the main problem in climate change, and more than likely the Origen of the problem, it is important to understand there is now not one, or even several factors, but many, with a variety of influence and differing values and effects, some of which have created a cascading knock-on effect or Climate Feedback Loop, where one problematic area creates another problem, cascading back through several levels, where solving the original cause of CO2 may not cure the knock-on effect.

There is evidence that once activated, some knock-on effects now have a life of their own generating their own momentum, the Arctic and Albedo, effect of air pollution from wildfire ash and melting of the permafrost and release of methane, the increase in the global temperature, and increase of water vapour pickup, being the classic example. Apart from the pollution and carbon releases, there is the influence of the political and cultural effects to contend with on a global problem, with disinformation being seeded from all quarters, so often from political and commercial groups who have a vested interest in one of the problem areas. War and conflicts, can not be ignored as a major area of climate change influence.

Certain groups, companies or political groups have fed information specific to their cause that bends the truth in their own interest on this. It is up to such groups as NASA IPCC, The WHO, and the UN. Plus the many academic bodies writing papers for peer review to try and correct the disinformation and create a stable flow of accurate information.

Architecture and the influence of the design of buildings, on climate change, with its vast use of materials and release of carbon during the manufacturing, construct phase and after with the building occupation and use, are major contributors to the global problem, and it is here where this paper will try to introduce ideas and methodology to help combat this area of climate warming emission.

Building Regulations are ideally placed to tackle and help control carbon use in all new buildings, being present in almost all countries (a complete list of the major building control regulations, a spreadsheet is being generated with links to all). Will architecture adapt, changing both materials and detail design, allowing humans to adapt to climate change as inevitably we will have to, not just in carbon use and eminence, but in all areas of construction affected by climate change such as flooding with safe living zones, heating, cooling, access, Solar collection and roof gardens with greywater storage? The IDD or Integrated Digital Design of any building will cast its influence over much of this area of research, and often offer a solution to some of the problems, led in part by the IT giants, Google and Apple, with CAD companies like Autodesk and Nemetschek designing battery and alternative energy storage.

Many countries will see the weather in a different way, the equator and areas around the globe associated with it will see temperatures rising beyond that which humans can tolerate, crops will fail to grow, and deserts will expand. Water will be almost nonexistent, in some equatorial areas, with northern and southern areas seeing a lot more rain in heavy downpours giving local systems a major problem, being designed in many cases, by Victorian engineers for far less volume.

Weather migration is now a reality and needs to be dealt with now before it gets out of hand, climate-change adaptation offers a route to at least solve some of the problems by redesigning or adapting architecture, but also a redesign of our approach to heat, or at least a better understanding how to avoid the inevitable rise in temperature.

Other areas will see warmer climates with the ability to grow crops which have never been possible, grapes and wine production in the southern areas of the UK and Nordic, but with this comes the inevitable plague of insects they have not seen till now, together with diseases finding a new home away from the intolerable heat and spread by wind, birds and humans. It is clear that to make any effective measures, a global view is needed, together with a good understanding of the science behind the

weather, the climate construction and the underlying political problems in order to understand the effects of all, and the actions needed to be taken.

This article will try to unravel the problem and offer insight into areas of research in **adoptive architectural design** that will help understand and guide future actions.

What we should be learning

A better understanding between climate change, and the cascading effect on the planet which will not respond so quickly to carbon reduction and require adaptive architectural design and detail to combat the increase in temperature, rainfall, sea rise and wind.

But not forgetting how we might contribute to the reduction in carbon use and release, with better detail, design via an adaptive architecture and reduction in cooling and heating with a good material selection such as structure, insulation, shading and orientation of the building and materials.

A better understanding between the various Building Regulations on a global scale, and how they might relate to architecture's contribution to climate change at both domestic and city level, by limiting carbon use and emission. Looking at just one area is a massive mistake, the weather is linked globally, so we need to look at the effects of Building Regulations globally.

Climate Change

There is no simple answer to the phenomenon called climate change. Yes, there are some leading causes, but fixing these will involve a long and complex operation, mired by political will, company profits and a lot of misunderstanding of the basic problem. Governments and leading authorities have given assurances that we can fix the problem and are battling against a time scale, but it will not stop a feedback loop that is now almost out of control.

The weather machine

To understand this complex web of interacting pieces of a weather jigsaw playing out its role on Planet Earth, we need to step back and review not one, not some, but all of the small, medium and large players interacting together on a global scale as part of the global weather machine.

Without a good understanding of the global weather machine, any meaningful comparison of the current problems in how the weather is changing and causing so much damage is meaningless.

Our first understanding is the way Earth's weather machine is formulated, and this requires a simple yet fundamental understanding of the formation of the four seasons, winter, spring, summer and autumn.

There is no alteration to these fixed points, just the way planet Earth reacts to them, and it is also important to realise four seasons means in effect eight seasons if we look globally with the Earth's tilt producing summer and winter at the same time, which is not the same as winter and summer, depending on the position of the earth in its orbit, perihelion or aphelion.

Next, lets take a look at what constitutes the weather, this interaction of the sun as the Earth orbits in a slightly elliptical off centred path approaching to sun 91mm at its closest with the southern hemisphere and 94.3 mm with the northern hemisphere, slowly spinning, with a tilt of 23.4 degree, always pointing in the same direction regardless of its orbital position. Producing complex air currents in the different layers of the atmosphere:

- Troposphere
- Stratosphere
- Mesosphere
- Thermosphere
- Exosphere

Whilst not part of the above we should not forget the actual edge of outer space.

Weather models

Weather models take the seasons and add in the insanely complex weather from all the weather stations, satellite reports from shipping, planes and mobile phone data to try and predict the weather as a global model, the calculations are incredibly complex and require a very high-end computer or bank of computers to compute. A series of Cray XC40 computers are in current use at the UK Met office. Watching the Earth's weather live on one screen, has long been the goal of meteorologists, and weather watchers. That is now possible with these powerful computers, predicting the outcome over time is the hard part.

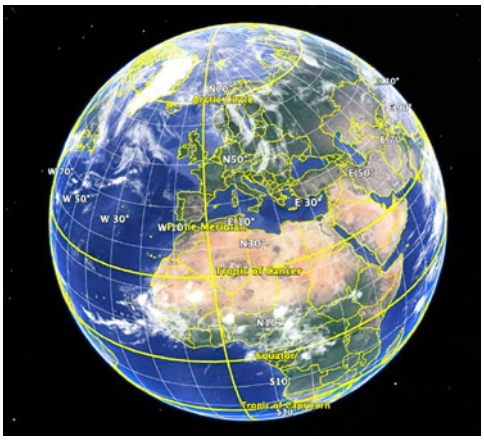
For many years the goal of a global digital earth has been the dream of so many mappers, and those who rely on maps to show information, yet the complexities of the Earth's ever-moving, and in so many ways, dynamic state, make it difficult to map, let alone display moving spatial data, such as temperature at so many levels, even at the basic stratosphere, and troposphere levels of Earth's wind currents, blowing over complex terrains which do not conform to any simple mathematical shape.

Mapping the live weather is done on an overlay of latitude and longitude, with wind currents that follow the Earth's ever-changing terrain, which can only be shown as a 2D representation.

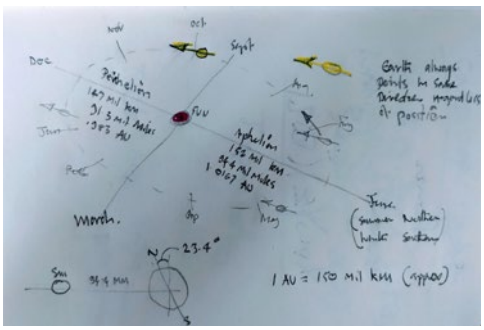
Showing the complex interaction of wind at all the different levels over every hill, mountain, forest, city and ocean in 3D is the hard part.

But the ever-increasing power of supercomputers, an increase in sensitive sensors around the globe, and the new breed of satellites that can measure so much more, at multi-levels in the atmosphere, is beginning to open up the possibility of 3D mapping and more accurate predictions, not just the weather but cross border pollution and the cause and effect of the jet streams.

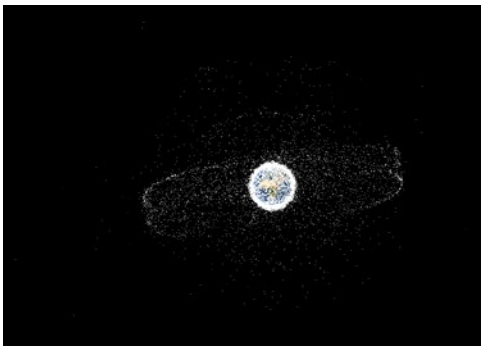
Google Earth is a classic example of a global 3D map, developed under the name Keyhole EarthViewer in the late 1990s as part of a gaming platform by Intrinsic Graphic, purchased in 2004 by Google and renamed Google Earth. Relying on images from the Landsat 8 to provide imagery in a higher quality and with greater frequency Google Earth, 2020.



These models gather data from a large variety of sources and apply a set of a very complex algorithm's to predict the weather, then do it again and again, refining, predicting and above all learning. There are many weather models, they never agree, different algorithms, data streams and needs, resulting in a differing result but by comparing models with reality, a consensus can be achieved.



The two main layers we need to be concerned with are the troposphere, which extends from Earth's surface to, on average, about 12 kilometres (7.5 miles) in height, and the stratosphere, between approximately 12 and 50 kilometres (7.5 and 31 miles) above Earth's surface. Within the troposphere, most of Earth's weather operates within this layer adjacent to the Earth's surface, most if not all clouds that are generated by weather are found here, with the exception of cumulonimbus thunder clouds, whose tops can rise into the lowest parts of the neighbouring stratosphere.



A digital Earth

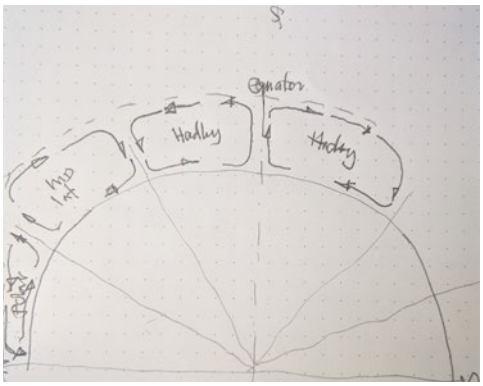
For many years the goal of a global digital Earth has been the dream of so many mappers, and those who rely on maps to show information, yet the complexities of the Earth's ever-moving, and in so many ways, dynamic state, make it difficult to map, let alone display moving spatial data, such as temperature at so many levels, even at the basic stratosphere, and troposphere levels of Earth's wind currents. Yet the complex mapping in 3D of weather is now one of many tools available for free on the internet. The Earth Nullschool website shows quite accurate weather conditions for quite a few parameters, wind solar and sea currents, is updated regularly and offers a very interactive 3D globe. The seri satellite map offers satellite mapping as a contrast.

What makes up the weather

The troposphere as we discussed earlier, is not still, it is a layer compressed by the weight of all the other layers and in a constant upheaval, by the action of the Earth's spin, called the Coriolis effect, on the atmosphere, directing it in specific directions, and the effects of the sun by day and the cold of night, the topography of the land and the sea, or water body of lakes and rivers.

To understand the flow of air and in turn the differing weather across the planet, we need to understand the six main cells of air circulation

With three in both the northern hemisphere and a mirror in the southern hemisphere making six in all, each would seem operating differently. Their range or effective circulation or zone of operation is normally about 30 degree of latitude, and normally named as specific zones:



- Hadley Cell
- Mid Latitude Cell
- Polar Cell

Although zone so often changes with the Earth's orbit around the sun, and represent the suns warming of the atmosphere and its sinking as the air cools, giving it a general flow path. Notice how the air rises at the equator 0 deg lat, creating a low pressure, at the Earth's surface, and sinks at about 30 deg lat along with the neighbouring Mid Lat cell, creating a high pressure at the Earth's surface.

The Coriolis effect is a reaction of the spin or the earth on the direction of the air within the cells of air. The jet stream also has a huge effect on the direction of the air, by controlling the location of the high and low cells that form.

Air pollution is an inevitable part of climate change, almost all parts of life produce some form of air pollution, the worst being wildfires producing ash that rises up high into the stratosphere and mesosphere via pyro cumulonimbus plumes and is distributed via the high winds and the jet stream, to all parts of the planet, in particular, the Arctic depositing a layer of dark ash over the ice, attracting heat, and staring the erosion or melting of the Ice via the albedo effect of dark coloured ash...

We discussed earlier how mountains, hills and valleys of the Earth are the next steps in understanding how the wind is pushed, moulded and directed.

- Terrain
- Rivers
- Floodplains
- Lakes
- Dams
- SUDS
- Landscape in general

All the above and more, add to the complex direction of weather, I have not ignored the effects of night and day, it just adds to the ever-increasing complexity of weather prediction and I hope highlights just how difficult the predictions might be.

What makes up the atmosphere?

Earth's atmosphere is composed of:

- 78% nitrogen,
- 21% oxygen,
- 0.9% argon and
- 0.1% other gases.

The remaining 0.1 percent consists of carbon dioxide, methane, water vapour and neon. Yet this 0.1 percent is what is causing all the trouble. Carbon dioxide the aim of so much action, amounts to only about 0.04 percent.

The reason is oxygen and nitrogen are very selective about what wavelengths they interact with they do not interact with the heat, and let it pass freely through the atmosphere. C02 on the other hand does interact absorbing energy and releasing it in in fall directions. About half goes back into space and the rest returns to Earth. So even though there is a small amount, its impact is huge.

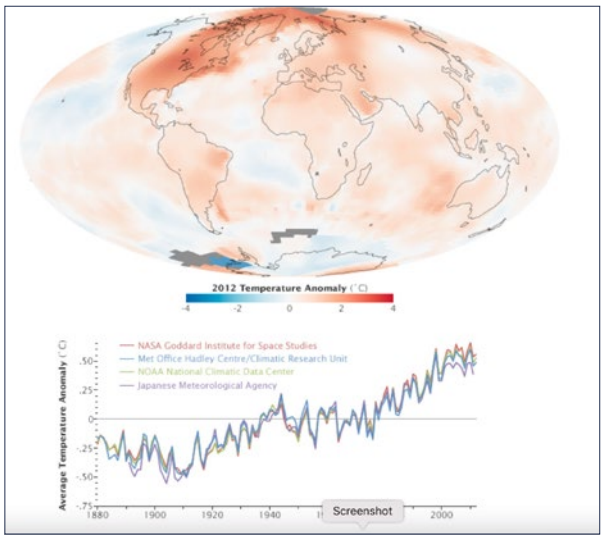
Water vapour has much the same effect but offers a new problem of dropping out and returning to Earth as rain. The more there is in the atmosphere to heavier the rain.

Global average temperature

Governments around the globe are trying to agree on a maximum temperature rise, based upon the global average temperature to keep the average temp below what is known as the tipping point, a level at which it would be extremely difficult to return to normality and a point where the weather would rise to a level unbearable to human life The datasets to begin the calculations are taken from over 32,000 land-based weather stations, several satellites and 1.2 million sea-based recordings from weather buoys and ships.

The calculations for a global average temperature are collected from all over the planet, from ship's weather stations satellites and monitoring stations, they are modified to correct for place and other factors to give a reasonably accurate global average temperature. When we see a statement that says 2021 is the warmest year on record, it is a conclusion from a variety of different atmospheric sea and satellite temperature data sets, using a variety of ways of measuring to avoid mistakes and errors. The combination of surface and satellite data sets provide the variety, and checks needed.

The value is therefore an average of all the modified



readings taken from four main data sets from the main weather centres. To change the value from say 1.5 C to even 1.4 C takes a lot of small countries to act, or one of the larger like the USA.

The tipping point

The tipping point for climate change is how climatologists describe the point in time when no matter what we do to halt or remove the underlying causes of climate change, it will make no difference, it will continue increasing to its own natural level. Often described as the end of humanity and a large proportion of life on Planet Earth.

Political agreements limit the rise in temperature to 2C but this is a global temperature value and so many areas around the world will exceed this. Some areas will not be fit for humans, and so many other life forms when this limit is reached. Spontaneous combustion small sparks, lightning, forming large uncontrollable wildfires destroying town and cities, not capable of resisting the heat and ferocious spread of flams. Lytton in British Columbia Canada reached 49.6C recently with disastrous consequences of fire destroying the complete town. A temperature level previously thought impossible to reach.

Global water supply

The world's water resource is one of the most widely distributed substances on the planet. In different forms and amounts, it is available everywhere. Within the air as vapour, in liquid form on the surface, as lakes ponds, rivers and the seas and buried deep underground.

Water forms a unique place on the planet, and is the most important substance on the landscape for life to exist, for, without it, there is little that can survive. Yet water can, when it comes in too much volume, can kill just as easy as it can give life in smaller quantities. Yet we treat this invaluable resource with contempt, reducing the potable part of the water chain by dumping so many toxic elements into it.

The total surface area of the Earth is 510 million Km^2, over 361 million km^2 is taken by the world oceans, leaving only 149 million Km^2 for land, where all of the potable water is found, the sea being saltwater and unless treated cannot be consumed.

Where water is found and the percentage:

- Oceans 97.2%
- Ice caps/Glaciers 2.0%
- Groundwater 0.62%
- Freshwater lakes 0.009%
- Inland seas/salt lakes 0.008%
- Atmosphere 0.001%
- Rivers 0.0001%
- TOTAL 99.8381%

What we have is it, we cannot make more once we pollute it, we cannot make more, and in so many cases we cannot clean it.

Water evaporation and its part in global climate change

Water vapour is the most abundant greenhouse gas in the atmosphere, both by weight and by volume unfortunately it is also a very effective greenhouse gas, absorbing long-wave radiation and radiating it back to the surface.

Compared to other greenhouse gases, water vapours does not stay in the atmosphere that long, being a shorter period of time than many of the other gasses, staying in the atmosphere for only a few days before precipitating out as rain.

Increased water vapour content in the atmosphere is a result of a warmer atmosphere, which is able to hold more moisture via evaporation from water sources and land, increasing the atmospheric moisture content, and the inevitable increase in rain volume.

As a comparison, carbon dioxide or methane will stay in the atmosphere for a much longer period of time, often as long as centuries contributing to warming formally lifetimes.

Groundwater

Water infiltrates into the ground through porous materials spreading deep into the earth. Filling pores and fractures in the layers of underground rock often making large aquifers. Some of this water although it lies far under the Earth's surface is extracted for both drinking water and industrial use.

Surface-water runoff, a major problem in built-up areas covered in concrete and impermeable roads, tries to infiltrate into the ground or return to the atmosphere, but often returns to the sea via streams, rivers, lakes, wetlands and reservoirs, with an increasingly large volume bypassing this natural sponge or waterway, via large stormwater drains and pipes.

Water and SUD's

We have seen previously that water is one of the most misused resources on the planet, We cannot make any more it does not grow, what we have is it. So, it makes a lot of sense to think about how we use this limited resource, by controlling its use, limiting the use of palatable water to just drinking, and using water that comes from washing, and as part of the process of shedding water from roofs, to flush toilets, and as part of the cloth washing process.

Storing both sources helps the usable volume of water to be kept to a level of usability. With rainwater not being consistent, careful collection and filtering of the return water from as many processes as possible, often called greywater, excluding water from WC's and urinals, called dark or black water, can be topped up via rainwater.

The large volume of hard surfaces now part of our roads and walkways sheds a huge volume of water directly into the stormwater system, bypassing the natural sponge of the earth, sending huge volumes to rivers that because of the confined spaces rivers are now allowed to use, limits their ability to take this uncontrolled volume of hard landscape water.

By controlling this watershed from hard landscaping and roofs with good SUD's management, via collection where possible as part of a recycling program, the use of retention tanks and careful release into the waterways, it is possible to prevent the flooding we now see.

The increase in the planets average temperature, and the knock-on effect of increased volumes of water vapour in the atmosphere is leading to more intense rainfall,

increasing the need to take SUD's as a major part of climate change control.

SUD's as part of any landscape design also offers the designer the opportunity to add a natural microclimate control to a scheme, adding shading from planting, water coursing to increase humidity, and as part of the retention system.

Wild fires

Large parts of the planet are suffering from climate change wildfires because of the excessive heat, this is causing another type of cloud to appear over the fire area called a pyro cumulonimbus plumes, these columns of hot are rise to the upper atmosphere and distribute ash and pollutants to vast areas, with ash from the USA's west coast fires is being drawn across the whole of the USA and some of Canada, with some of the ash is falling on Arctic ice and glaciers.

Take the singular USA wildfire problem and add all the other wildfires that are now raging across the globe, which is producing a lot of ash that is being lifted by the rising air to high levels and distributed via the jet stream. Its clear wildfires are now a major part of climate change driving an increase in temp via the albedo effect, on ice fields, turning them a dark brown. This in turn absorbs heat and melts to snow and ice below.

One of the major effects of this very hot plume of smoke and ash is the generation of a lot more lightning, which in turn is creating more wildfires.

Although it is not completely clear why, but this change of airflow, caused by the pyro cumulonimbus plumes, and a particularly hot summer is disrupting the jet stream. This fast- flowing volume of air that exists between the polar and mid-latitude air circulation cells that operate in the lower layers of air called the troposphere.

The hot summers and the effects of the wildfire plumes are causing a collapse of the polar vortex, the volume of swirling air over the polar regions, that is altering the air cell circulation and in turn, the weather of the northern hemisphere, certainly several weather prediction models seems to indicate that weather in the northern hemisphere might change for the worse.

The great ocean conveyor belt

Add to this the worries about the natural ocean conveyer belt, a global flow of water taking in most of the great oceans flowing from pole to pole, taking 1000 years to complete a single cycle. The disruption in its flow pattern is caused by the heating of the Arctic north pole. Warm water as it flows from the south is cooled by the Arctic and sinks returning back at great depths to rise again as it warms and starts the cycle all over again. If this is interrupted, then several countries will not be warmed by the flow of warm water and return to a different weather pattern, continuing the knock on weather effect.

The UK is in direct line with this. We owe much of our temperate climate to the warm currents. Remove them and we will see a turn for the worse in our weather. Many scientists are now saying it is not, but when?

Solar irradiance

Solar irradiance is the power per unit area received from the sun in the form of electromagnetic radiation on a regular grid as measured in the wavelength range of the measuring instrument. The solar irradiance is measured in watts per square metre in SI units. This basically means the area of the Earth's surface in relation to the sun's heat hitting the Earth. It is all tied up in the orbit of the Earth around the sun, the tilt and the constant direction of the tilt.

The tropic of cancer and capricorn are the natural limits of the height of the suns power with the sun being at 90 degree to the Earth's surface. The tilt and curvature of the earth, increasing the surface area, above and below this line, hence the mild climates of the northern hemisphere.

Albedo effect

A simple process but this effect is light surfaces reflect more heat than dark surfaces, and this is called the albedo effect. Ice is very good at reflecting the energy and helps the polar caps to remain frozen. Falling ash from the many wildfires discolours the surface of the ice and removes the albedo effect increasing the surface temperature and melting the ice beneath. Volcanos also create the same effect. Ice can reflect about 85% of the sun's energy, in contrast to the sea which is a low 7%.

Icecaps – ice loss

The effects of mostly the albedo effect loss on the icecaps is reducing the total area of ice, in particular, the Arctic, together with sea warming is seeing a collapse of the northern end of the great ocean conveyor belt, see above, where warm water travels north hitting the cold plan caps and sinking as the sea's density increases, and flowing back at great depth south. The collapse will eventually alter the whole of the northern hemisphere as places like the UK Ireland and northern Europe loses the warm currents and returns them to hard winters of the Canadian and Russian inland areas of the same latitude.

The loss of so much ice from the polar regions and the effect on the planet is unknown, certainly, the wobble dampened by the ice, is starting to increase, albeit very slightly, but measurable, and the loss of the weight of almost 2 kilometres of ice from the Greenland interior is allowing the Earth's crust to move, it is not known what this will mean but it will have an effect. Certain businesses are undoubtedly pleased by the icecap loss, particularly the shipping fleets who now have a route along the northern coast of Russia, primarily for the shipping of crude oil to new sites to convert crude to petrol and easy shipment to Europe. It seems like more bad after bad.

Permafrost

Large areas of the Arctic contains frozen earth called permafrost, which are both within the ice cap and beyond. The permafrost is not a new phenomenon and as such most of the permafrost is quite ancient and has trapped within the frozen ground a lot of methane, now being released giving rise to the phenomenon called rapid release of methane which has released huge amounts of methane to the atmosphere, in 2013 this was estimated to be 17 million tonnes increasing year on year.

Unfortunately, many buildings have been erected within the permafrost zone, the melting has de- stabled the foundations of a vast area making a lot of buildings unusable. Piling and extending the foundations to a safe level is a possibility for some buildings, but the vast majority of affected buildings will need to be demolished and rebuilt.

Like so many of the climate change knock-on effects just looking at carbon reduction as a cure is not going to solve this problem, it is now past any tipping point, whether it can be stopped, is a new problem, and not limited to the loss of the permafrost, the release of methane and water vapour in huge volumes only adds to the knock-on effect. Decayed vegetation and the possibility of viruses and disease frozen for so long now also being released is being assessed.

Ocean warming

The global warming and rapid rise in temperature, has had a huge effect on the sea rising the temp above that at which many fish and mammals can withstand, also a lot

of plans in the form of the corral, and as discussed earlier, a disruption to the natural circulation known as the great ocean conveyor. The natural circulation is dependent on the Arctic cooling the sea as it approaches, sinking and returning it south in the two major oceans, the North Atlantic and Pacific. It takes approximately 1000 years to circulate this planet-wide conveyor belt.

Coastal sea

Adding coastal sea to this section of the paper might seem strange, but the sea is mostly an outlet to all the waste from the land, all rivers one way or another outfall to the sea, and it is the coastal waters that are affected the most with all sorts of effluent, chemical and other discharges, that affects the quality of the coastal water. The inevitable rise in sea levels from melting arctic ice and Greenlands massive ice fields often several km deep will affect the erosion of coastal areas and affect plant and mammal life. This can already be seen in other parts of the globe. That has been affected by rising sea levels and intense river volumes washing away land. The Ordnance Survey data station at Newlyn, which provides the base for the OS maps contours and subsequently the storm and foul drains in the UK, for over 100 years, is now seen as the ideal source for monitoring sea rise from the equipment that fortunately has been maintained in working order and still provided a data output of sea levels, along with 43 other stations dotted around the coast, together with other stations in Holland, Belgium and France, to give an overall picture of the coastal sea rise.

Around the world, local communities are reacting to the rise in sea levels by planting salt water- tolerant trees to form mangroves that will hold onto the river and sea banks with their root action. I raise this point again later in the article. Other areas are slowly being swallowed up by rising sea levels to which there are no real effective measures, other than tidal barriers which are only a short-term measure. The future for these islands and coastal area looks grim.

Maps now being generated show large areas at risk. Populations in these areas are slowly leaving, seeking a safer area to live. This people migration is not limited to sea rise, but can also be seen in areas of increasing heat, and shortage of water, people migration is a new problem for small communities being seen as safe, but not really ready or able to accept a large influx of people, their infrastructure in services, and support, geared to a small population. For the UK, the UK Government document *Future of the Sea: Current and Future Impacts of Sea-level Rise on the UK* offers an insight into the erosion of coastal areas under threat, although sea-level rise projections are based on a lot of different data with complex wind tide and large scale fluctuations in the global weather patterns, are at best are uncertain but rise it will.

Planning controls contribution to climate change

Most regulations around the world are based upon rules, derived from local history, Politics, events use, weather, and geological position. Their regulations have evolved to meet local demand. So often guided by local materials and construction methods. Baer, W. C.1997

But recent years have tried and tested that scenario with weather that is evolving together with a global material marketplace offering a cheap supply of materials, that were designed for different markets, and failed to migrate not just to the new market, but the weather changes, reaping havoc on that country.

Many countries are linked directly to neighbouring countries by land, and river, and indirectly by air. The effects on weather generated by Planning Control often separated from a city's Building Control, but the policies of orientation, material choice, density and traffic, both pedestrian and motorised, have a huge impact on the technical aspect of construction regulatory design and use.

The so-called city or urban heat sink is in part a function of external colour and texture choice, which so often relates to the density of that material. Careful orientation and adequate shading from natural trees vegetation and an active SUD's plan, plus structural Brie Solee construction are ways to limit the problem.

Every significant design, no matter where it is situated, goes through some form of planning, It is here that most of the external materials and the elements as a whole are decided, mostly because of their look and appearance. Their relationship to each other, and what the combined visual effect is. But so often any concept of manufacture, energy use, its effect on the building's occupants, let alone its effect on the climate is so often ignored.

Cross border migration and political will

However good a city may or not be at controlling the urban heat sink, the effects of pollution, heat are passed across borders from linked and none linked countries, often called cross border pollution migration, with often disastrous effects, which in some cases is received second and third hand as the wind travels across the planet.

To evaluate and hopefully control the problem it is important to develop a full understanding of all areas involved, what regulations are contributing to climate change and the weather's migration effect across many border crossings.

The Earth's temperature rise can clearly be seen from graphs generated from ice cores and latterly tree ring analysis. Where the ring growth is compared to thermometer temperature readings extending back only 300 years or so to the mid-1700s and extended to the current days rise in temperature. The initial drivers of climate change being centred upon the rise of the global industrialisation of predominately the northern hemisphere and lately the southern and none industrial areas catching up with the earlier industrial countries, such as China, India and Africa.

A complex interaction between climate weather passed on via road, river, groundwater, and often the geological effects of terrain, and mountains funneling weather. There are however certain areas where control of construction was based upon the rules centred on the designer's country, using local weather patterns of their own country. So often a mistake, given the changes being inflicted.

The change in weather often came slowly and unnoticed, and in places ignored or not believed, thinking it was a one-off, the 1 in a 100 event, little realising it was anything but. Doubter as they were called, started bringing in evidence to pour cold water on the idea that the weather was changing. Led by the manufacturers of the base cause, Carbon, produced by a number of petroleum, coal products. Not forgetting the human involvement or driving force in our quest for quality of life. Compounded by a portion of the press who just did not understand the data being used and the statistical analysis being used, by a global scientific community.

Government's were reluctant to inflict change that might result in more onerous regulations pushing up construction costs to an industry that might well be sponsoring that government.

Adaptive architectural design and human adaption to heat

No matter what is done to slow down climate change, and try to remain below the limits set by Governments around the world to the global average temperature, by

reducing carbon. There will be a need to change our views on architectural design and human adaption to heat in all areas of use, from domestic housing to commercial to industrial, simply because curing the carbon content of the air will not produce immediate temperature reductions, the knockoff effects of a rise in temperature on the ice caps, and glaciers will continue to reap destruction. Therefore, architecture needs to adapt to this continuing period of warming and climate change that will last for a considerable time.

Areas to consider are dependent on location, but what is quite clear is the need to adapt architectural design to compensate for the various effects of climate change, such as orientation, alternative non carbon heating, solar power, lower power appliances and stack ventilation.

Huge housing estates are so often designed not with orientation in mind, more the number of units that can be fitted into a given site, which so often results in houses of a common design, windows to the front and back with little or no windows to the side elevation, being orientated to allow the house to fit the plot, not how it might gain or shade the solar orientation to suit the house design and occupation.

Although the cause of climate change is well known, the cure is far from easy and will take time to halt, and reverse, in the meantime temperatures will remain high, and rainstorms will increase in volume duration and frequency. SUDs need to be a major design factor, to reduce the hard standing, store good greywater and slow down the way rainwater drains away.

Rather than battle the rise in temperature, architecture might do better adopting designs that accommodate the heat without consuming expensive power or adapting solar alternatives. History shows this is not a new idea, Hot climates have long practised solar orientation, clean water storage, and careful planning of buildings and their orientation.

Humans might also seek shade more and find places that are cooler, rather than turn to air conditioning, the use of public buildings such as shopping centres and buildings open to the public to cool, supermarkets need to use a controlled atmosphere and are air-conditioned more efficiently.

It is clear from the way the climate is changing, that whatever we do to stop the rise in temperature, too many countries are dragging their heels. It is not going to be an easy job to push them along and change their ways despite major conferences and hard-hitting reports, and being hit by the knock-on or cascading extreme weather events.

An alternative approach is needed to deal with the related consequences of a global 2°C average plus, rise in temperature. The cascading effects of the rise in temperature are going to be felt during the fight to reduce greenhouse gasses and long after as the planet tries to heal itself, and in many cases, the wounds caused by the cascade effect will never heal.

Our present construction techniques, designs and building materials, are designed to cope with a way of life we will not see again for many years and are in so many cases incapable of dealing with the increase in rain, wind and power consumption.

The term adaptive architecture can be assigned to the way a building and its surroundings are modified to deal with, and in some cases gain from the increasingly diverse weather, climate change is bringing. Not all changes we may want to bring in are or should be aimed just at reducing carbon. Cleaning the atmosphere is a more correct way to bring attention to the problem of removing as many of the gasses as possible to normal levels of say a pre-industrial age, methane CH4, ozone depletion, and CO2.

Many of the changes should be seen as a collective approach, linking changes within the fabric of a building and tying them to external resources.

People climate migration

Failure to consider any form of adaptive architectural change to both new and existing build might drive the population away to areas considered safe, or to areas that have adapted to the temperatures and other consequences of climate change. The consequences are huge, leaving an area creates ghost towns, no income for the ones who stay, and more specifically for the town council to enact change.

For the towns and cities that welcome these migrants it is not always clear to the councils, just what it means, greater pressure on the services, and so often older electric and gas energy supplies not being clean and increasing the CO2 count and city heat sync.

Energy creation and use

Our use of energy across the many different ways humanity needs its power to drive and sustain of lifestyle needs to change, all of the old ways are the generators of the problem we now face, an atmosphere full of CO2 and the resultant rise in temperature.

We cannot exist in this fuels paradise of fossil fuels, we need to find better ways, solar power offers not everything, but it gives us room to cut the ties to the almost uncontrollable output of CO2. I show later how adaptive architecture could adopt new materials to collect the suns energy in multiple ways, both pitched and flat roof offer so many alternatives.

AC or DC is an argument we need to raise again, Local collection of PV electricity need not be converted to AC when DC is all that is needed to run a lot of domestic systems, many of which are intrinsically DC anyway using transformers to step down the electrical flow. Long-distance transmission for large industrial use should remain as AC.

The use of alternative heating that is more efficient should be looked at. Air source, and ground source heat pumps offer a far better heating system than gas boilers but are often bulky and noisy.

Although hydrogen is now being promoted by some of the major UK boiler manufacturers, certainly in my area the old gas mains are being updated, presumably to take the new gas. Although I see no means to supply the volumes needed, Hydrogen is a green gas, but its manufacture is not.

It is with solar panels that a lot of hope rests, with increasing performance and rotatable panels tracking the sun at optimal angles, together with new forms of solar collection embedded into elements like glass and roof tiles.

Storage technology increases daily, driven by the auto industry, not as a separate technology, but as one that can be incorporated into architectural buildings, sharing electricity when not needed by the car. The energy gained from solar and other methods, need not be stored in battery technology, kinetic storage might also be explored in both domestic and industrial/commercial buildings. Compression of air linked to a turbine to generate electricity could also be highly adaptive to modern living.

Palatable water

I discussed this item earlier, but life is reliant on palatable water, a huge amount of resources are committed to providing this resource, shipping it via pipes to where it is needed. The total surface area of the Earth is 510 million Km^2, over 361 million km^2 is taken by the world oceans, leaving only 149 million Km^2 for land, where all of the

potable water is found, the sea being saltwater and unless treated cannot be consumed, which in itself creates a knock-on effect of damage to the ecosystem of the sea.

The availability of potable water is continuing to drop from the effects of contamination, from industrial waste, bad livestock farming practices and agriculture in general.

Sustainable Urban Drainage or SUD's is the control of stormwater, from both the roof of the building together with water from some internal appliances such as baths' showers, and sinks, and retaining it for reuse within a building to flush toilets, called grey water, via its initial storage and filtering on site, with a portion returning to internal tanks, and the excess dealt with via overflows to swales or small watercourses, ponds and its eventual exit from the site to streams, return wells known as water discharge to ground, and storm water drainage. All these small but very effective measures add to the reduction of pressure on palatable water, saving it for drinking, and not wasting it flushing WC's.

Retention of water for each individual building, domestic or other is an important resource to be built into homes as part of its adaptive design this can be used in multiple parts of the SUD's (Sustainable Urban Design) to flush toilets, and as part of cloth washing when treated correctly. But it can also be used as part of a buildings own fire protection system to provide a mist cover to a building, as part of a fire protection system, which can be used on a variety of buildings with differing occupancy.

Water retention so often stored externally on existing buildings can now be brought in when new buildings are adapted in other ways to cope with climate change, such as raising the ground floor sufficiently above the external landscape to accommodate the inevitable flooding we will need to deal with. Adding basements in a flood zone is not an effective design solution, but raising the ground floor is.

SUD's is also a major factor in reducing the volume of water allowed to bypass the natural sponge effect of the earth leading to vast volumes of water being deposited into the streams and rivers.

Retention tanks allow groundwater from hard landscaping i.e. carparking, to be stored and released gently helping already overloaded rivers, with reduced natural flood plains to cope.

Smart cities

The use of adaptive architecture is giving rise to cities that might well be classed as smart. Here, technology in the form of sensors, computers and a network to link them all together, are aiding the flights against climate change. Humans are ineptly bad at controlling themselves yet alone complex buildings or cities. Yet computers with the right information, and adaptive programming algorithms, are showing they can.

Local generation of electricity generated by solar panels and a new generation of components such as glass and coated finishings that generate electricity can power networks without any carbon emission. Unlike the big central power plants that run on coal or gas, both high carbon generators.

What smart actually means is a controversial point. How far does the term extend? The general feels is as far as it can, from orientation, materials, energy use, to social the economic benefit for adopting the smart concepts of design. Does this include transport, a major contributor to almost every city?

The smart city concept, in an established city like Birmingham, is different to a new city like Songdo.

The term digital twin is being used to allow the original design CAD model to monitor the various buildings and the sensor network of the building. Is this important in climate change, well yes, clients so often commission a building only to miss understand its design, or the staff running the building do as they think best. By linking the building's network back to the original design model, the buildings use and efficiency can be monitored.

Electric vehicles and local solar charging is a must for any smart city design, but so should the connection to other cities, travelling to and from communities should and will not stop, automated EV transport utilising solar electric generation to maximise long-distance travel is now available with cars that automate almost all of the driving, travelling at speeds that are right for the vehicle not the haste and impatience of the occupants.

Solar power is predominately DC and power station AC, the two can be used together, it just takes action from designers to install DC plus sockets that a vast majority of appliances can and should use, instead of transforming down from AC to DC for each individual piece of equipment. Leaving an AC network for large power demands.

Open space

Is external space just something that the users of a town or city need and want for pure recreation, or has the space another function and be an integrated part of a smart city even if it is not digital, but more social feel good, helping to control a local microclimate?

The answer to this is yes, any space will have multi-functions, some associated with the building in question, and other functions that are for the area, and wider activities, accessibility, visibility and suitability to special needs.

But open spaces might be used to defend against city flooding offering a city flood plain, all be it hidden as an underground retention volume to absorb the increase in rainfall, provide a buffer to excessive wind speeds, and if planted correctly a carbon sink, and this is the link between social feel good and a digital city.

Carbon count

Carbon embedded into the materials used to build should be limited, and this included the carbon emitted to manufacture, the carbon emitted to transport the material to the site, and the construction carbon emissions from site equipment. Lastly, the materials inbuilt carbon can be listed as part of the release on demolition at the end of the building's life.

Could SUD's also be used in this simple count, adding carbon from wasted opportunities to save water?

Smart cities can and should monitor the carbon emissions from all sectors, could the system inform bad polluters, such as individual building owners. Digital twin technology can and should easily start to monitor the effects of large cities on climate change, old or new.

Timber

Timber offers the industry a unique building product that can remove a lot of the carbon heavy materials currently used in construction. It is a natural store of carbon filtered from the atmosphere, no longer seen as a poor structural material, with several high rise buildings being designed and constructed with timber.

Good detailing, and a better understanding of products that may be constructed with timber, or laminated timber offer so many advantages, the feel-good factor and natural weathering of timber far outweigh the harsh carbon-rich materials like concrete and cement mortar and are so often easier to protect, and when necessary, replace.

But like anything to do with climate change, the replacement of many common carbon loaded materials with timber requires a change in the way we plant and

harvest timber. The planet relies upon the living tree to regulate so much of the atmosphere. Just decimating large forests to feed the global timber market is not looking at the way timber as a whole is needed by the planet. We talk of a sustainable approach, this need to be expanded by looking at not only its replacement but how the harvest of trees will affect the planet. The certification system operated by the Rain Forest Alliance which not only looks at the trees but everything associated with it, the forest, the animals, the insect's regeneration and the soil. The UK Woodland Assurance Standard (UKWAS) is another excellent standard.

Fred Pearce's book *A Trillion Trees* is an excellent book on the subject.

Climate change, however, is causing yet another problem, trees grow in a climate-specific temperature range, too warm is bad, too cold and they just do not grow. The tree line in the north has since the temperatures started to rise, has slowly crept north, but in recent years it has started to creep at an alarming rate.

The staple of our industry, the Douglas fir is under huge pressure, as the southern European forests suffer from the heat, and we wait for the new forests to mature. But as always planning forests is not a simple affair, it takes time for trees to grow, and we need to rethink what species we will need. Planting in a straight ridged row is not good, for wildlife, and without wildlife, the ecology fails. Even more, of a reason to step back and examine our use of timber, and as mentioned earlier, the certification system. Ben Rawlence's book *The Treeline* is another excellent read and covers Scottish forests in detail.

The introduction of Building Regulations

The Building Regulations were first introduced to control safe build construction, regulate construction methods to reduce collapse, and offer a series of design recommendations as to Health and Safety.

The UK's first regulations were introduced after a fire in London in 1212, with the subsequent ban on thatched roofs in London, other cities followed London's lead, but the main building material was still timber, with no thought to the way buildings were in effect stacked on top of each other over-sailing till the top floors were almost touching, and very little light could reach the street below. It took the great fire of London 1666 for stronger laws to be enforced, resulting in timber structure being banned, with the London Building Act 1667. From this point onward the regulations in the UK evolved, with each city or area providing their own version as local bylaws, specific to each area with no link to neighbouring city's laws. It was not until 1964 that the United Kingdom adopted a national set of regulations following Scotland who introduced their regulations in 1963, Northern Ireland in 1972 and the Republic of Ireland in 1990.

Over the years changes were made to answer technical problems as new materials became common, or public awareness required some form of action and regulation. Thermal requirements were and still are a major section of the building regulation (Part L in the UK).

Drainage was also a major section, to alleviate the role of the road gutter as the main route for effluent waste with the introduction of a first a single pipe to take care of the problem then a dual system to remove rainwater from the combined pipe. Not all changes provided a complete answer to the perceived need, often changes opened up different problems, and can easily be seen as part of the increasing effects of global warming. This is evident in the rapid removal of rainwater to the major rivers increasing the volume without the rivers being able to cope with the increased flow. Hence the need to implement a SUD's plan to mitigate the misuse of water.

The UK model of Building Regulations contains a lot of easily understood law, with a copious amount of easily understood technical drawings to explain material positioning, scale and relationship.

Each country has adopted a similar approach to controlling the technical construction techniques some following the UK model, but others reinventing their own version.

Regulations, as can be expected, were introduced to provide a safe building, it should not fall down under its own weight, it should provide a watertight cladding, and not catch fire. As years go by specific rules have been added to combat rising energy prices, staircase accidents, heights of rooms, means of internal escape. And to a check on a materials fitness for purpose, the agreement system that makes use of the British standards. But little in the way of controlling climate change, either by material manufacture control, its use in life or its end of life demolition The in-use of life includes cleaning, and so often ignored, the vapours and emissions in the early days after manufacture, i.e. solvents and other gases.

My continually updated schedule of global Building Regulations shows the vast range and diversity around the globe. How many countries look at and try to control material manufacture, energy generation and use in any building. The efficiency of any building is down to many factors, most of which are controlled by regulation, but the generation of heat from whatever energy source, is not, other than as part of SAPS or other whole building calculation.

Add to this an ageing building stock of all types, giving a large hole of uncontrolled energy use with little measurement other than the owner's own bills. So it is important to review all forms of available energy to the building and fit the building to its energy needs.

The current new wave generation of solar and other sun-related energy generation relies upon the ability to store energy in the new breed of home use and the vastly changing auto industry.

Lithium is the go-to material in the manufacture of battery technology. Tibet, Chili, Australia and now Mexico are the major suppliers (Top ten biggest lithium mines in the world, 2020). New technologies sit in the pipeline offering a huge increase in performance and longevity together with new ways to incorporate into the external skin not just as fixed ridged panels.

Sensors

The rise in sensor technology, and the underlying network, often named the IoT or Internet of Things to support the widespread network traffic. Adaptive architecture will rely heavily on sensors to help understand a buildings use and its adaption to change, see my comments on digital twin technology earlier.

Sensors come in many sizes and use, allowing data to be used to measure so many things from the actual carbon content of the air, thermal and structural conditions of the complete structure, together with internal traffic of bodies.

It is clear, sensors offer a wide range of use in any new and for that matter older or historic building. From temperature control to air movement to security. Giving both the designer and building owner valuable feedback on the health and running of the building.

Powering the sensors is often a challenge, a new build is relatively straightforward in supplying live power feeds and if required a data cable, if Wi-Fi or Bluetooth is not sufficient. But so often in refurb of existing buildings, in particular, buildings with historic value, alterations to the fabric are not encouraged and are often forbidden,

alternative methods of poor and data retrieval are needed.

Adding batteries is a short-term solution, that unless surface mounted require changing or charging. Near field, technology might well be the solution, but for sensors that need to be buried deep into a structure, alternative means are needed. Backscatter technology developed by a team at the MIT, has secured a way to harness the ambient energy in the air and this is proving sufficient to partially power a sensor for small burst activity to get a reading, and transmit, then wait for the unit to recharge before making another reading.

Whatever the method, sensors are going to revolutionise the way we see how buildings work, offering a greater in-site into material performance and building use.

Sharing the 3D CAD models with the client, as a digital twin, embedded programs within the model will compare the initial design with this incoming data. A very valuable asset when clients or building owners want to sell or lease their building.

But the data collected, if it falls into the wrong hands could be used in ways, not in the generators favour, offering malicious alteration of the system to the favour of thieves.

The fire service will find instant plans in the 3D format a valuable asset, when having to enter a building on fire, although sensors will help prevent so much of this by activating misting systems, to prevent fire spread.

Data collection

So what data is being collected, and can it be separated from central open storage to private storage that might add values to the building in terms of maintenance, thermal performance and energy use? I also include security data, the movement in and out of the building. Open windows etc. sensors and the new 5G IoT offer a huge safety net to building owners on the way, a building is used, maintained and so often upgraded.

Is the data valuable and better still is it useful to the building to look back to see how it handled itself in a variety of scenarios? The answer is very much yes. Even to the point of detecting material failure or suggesting better ways to manage the efficiency of the building.

As described earlier, a digital twin CAD model offers a way to use the BIM model in totally different ways, adding not only to the data stream but as a major feedback to the designer.

Misinformation

Although global warming has long been understood by the major oil companies, a barrage of misinformation has steadily been planted into the news media to deny that fossil fuels had anything to do with global warming. This is inevitable as big manufacturers face a reduction in their turnover as their particular materials face bans of simply lose market share to similar or more effective techniques.

There is no simple answer to this problem, good research, and testing by reputable labs is the obvious answer, but so is training and robust construction education, with an open data source of material used.

Does this have value? The answer has to be yes. It is like a car without a logbook, as to one that has all services recorded, the annual mileage and trips recorded. Why is it not added to any sales document? In another paper, I looked at learning cities, how information learned helps direct change.

Coastal space

Again, as described earlier, as seas rise, and in some cases, cities sink, plans need to be made to defend that city against the increasing ferocity of the weather, from wind and rain, and the cascading effects on services.

There are no rules here, and many answers to the problem, adding defence walls, installing sophisticated drainage, or moving the entire population have all been tried one way or another, but perhaps there are other methods, such as the adoption of a coastal sustainable urban drainage system, or coastal SUD's plan, a way to use coastal wetlands to defuse incoming weather driven by the oceans, together with the adoption of ways to store or hold back the release of large volumes of rainwater in both internal storage or as part of a diverse wetland. and treat it as the valuable resource it is.

In many cases, Victorian seafronts are within feet of the beachfront defence wall and are most susceptible to damage from waves. Given that sea levels will rise, this puts these houses at extreme risk. The current sea wall defences obviously need to be redesigned, together with ways to protect these at risk houses.

Temporary barriers have proved effective in river defence work, can the design be adapted to provide winter protection when the sea is at its worst.

Sustainable urban drainage

Although I looked at this earlier, I think it wise to expand on the whole concept of sustainable urban drainage. SUD's is not just about looking after water, often it is about, living with water, Climate change has passed the so-called tipping point in many areas, and the rising sea levels are going to be an inevitable part of life in many areas of the world. Trying to hold it back in many areas is like Canute sitting on a chair on a wide-open beach commanding the tide to go back, it is just a waste of time and effort

Adapting our design skills to offer simple alternatives like raising the population above the water levels by stilts, not an unknown method but rarely talked about for a modern city. Even simple steps such as adopting internal defences to individual buildings can be adopted by individual owners from house owners to commercial buildings.

An early warning system is the first step, local news and weather channels now give detailed updates on incoming weather, this should be noted and acted upon, by any building owner.

Window and door shutters offer a building a good defence against driving rain and damage by wind-assisted missiles like chairs, signs and the like. Roller shutters hidden inside the window or door lintel is an easy installation on a new build, offering both internal and external security and weather protection. For retrofit to existing buildings, other designs are available that can be either permanent or semi-permanent, the latter fitted when warnings are issued above a certain level.

Again, so many different designs are available.

New designs also offer ways of incorporating alternative layouts on both the space internally, and its protection from flooding. Lifting the ground floor living a meter or so above the external ground level offers protection to the living space from potential flooding. And providing a space below to house grey and dark water storage, with greywater filtered, and cleaned, in self-contained units that can operate when flooded, and provide easy access for maintenance in normal times, together with car parking and nonessential storage that will not suffer from floods

The use of storage for greywater offers occupants a way of storing water for nonessential use, cloth washing, flushing toilets and possibly showers. Tie this into dark water storage for effluent will help in times of flood to store effluent efficiently, reducing the need to flush to sewers that are overloaded, and spill into the floodwater creating the potential for increased disease.

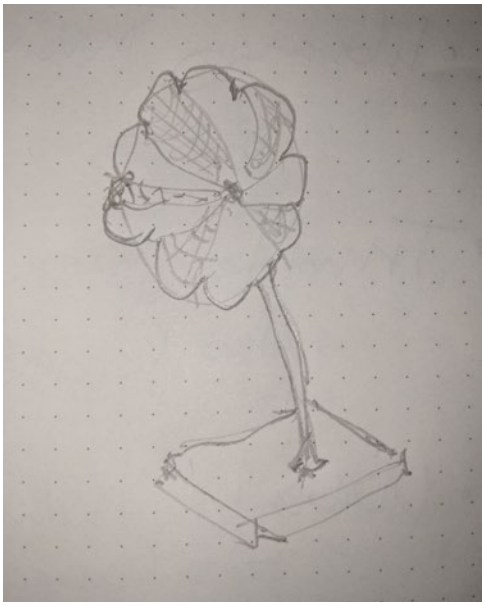
Pitched and flat roofs are difficult to design for heavy

winds, yet with careful detailing both can offer building owners a safe refuge and short term accommodation. A flat roof offers perhaps the largest portfolio of opportunities, from water collection to alternative garden space.

As climate change inevitably raises sea levels, water tables are going to rise, in some cases permanently, and raising street levels and building floor levels might be the future. Flat roofs will offer garden and external recreation space and an area for satellite and solar panel installation.

Solar panel design currently is rectangular, but new designs are being offered to mimic pitched roof tiles, but flat roofs offer designers an opportunity to create collectors that fit the space more effectively, and become interactive with the weather. Stored in a compact format for inclement weather, but opening up in better weather to take full advantage of the suns location and altitude.

External raised patios on stilts could easily extend living space above any flood level, extending the roof garden with both access and functionality.



Some form of energy storage is essential in future buildings where reliance on the electrical grid is so often disrupted but storms. And internal energy store will collect solar feeds and store unused energy in battery stores within the building. Not I might add in any basement area subjected to potential flooding.

Topping up from the grid and in many cases feeding to the grid is a viable source of income from investment, but having power in times of storm is essential.

Greywater cannot be considered as palatable water, so a third alternative drinking water storage should be considered. Bottled water is by far the easiest to store in refrigerators.

Taken from the Environment web site

Rivers, controlled by the Environment Agency, is the principal flood risk management operating authority. to manage flood risk from designated main rivers and the sea. responsible for operating, maintaining and replacing an estimated £20 billion worth of flood risk management (FRM) installations.

The Environment Agency carries out an advisory function in development control – commenting on planning applications within flood risk areas, providing advice to assist planning authorities in ensuring that any development is carried out in line with the National Planning Policy Framework.

The cost of climate change

The damage disruption, loss of life has far-reaching consequences, someone somewhere has to repair, or install damage control measures, as a consequence of climate change, some support comes from insurance, some from Government, but sadly a lot of the cost falls on individuals, who sadly cannot afford the huge cost of repair.

The damage to wildfires in just the Northwestern, Central area of the USA inflicted more than $145bn of damage, add to this severe weather damage, and Tornado's, the list is huge, added together the USA alone faces cost in the trillions, on a global scale it is mind-bogglingly huge. Yes, as I mentioned earlier companies will stand to reap a lot of this in the supply of new materials, and labour, but forests are not an instant fix, time is also needed to repair the damage. But time is not the all-encompassing healer we perceive, it does not return to the original state, the effects, as I mentioned earlier have a knock-on effect, often choosing another alternative route of repair, causing yet more damage, and cost.

Conclusion

We need to understand so much more, the way of the Earth's weather machine, together with so many side issues of tree husbandry, soil mechanics. And unfortunately, politics and big businesses, playing a major part in the climate change routes each country might take.

Many of these global large businesses are looking to climate change as a source of investment, as they increasingly see large profits from switching to clean energy and safer material sources, energy production, battery storage, and the almost meteoric rise in EV transportation, and the digital spinoffs, of data and analysis.

Large existing cities are difficult to adapt to climate change, but there are ways to help the climate battle, with open spaces, reflective roofs, roof gardens better SUDS and an adaptive architecture approach. Opening up parks in city centres with retention tanks under them will help water retention, reducing the volume of water flowing out to rivers, and most of all the trees will help manage the microclimate.

New cities offer a vast pallet of possibility in changing or using adaptive architecture to design in such a way as to not battle against an inevitable rise in temperature and water shortage, but to allow flooding, and reuse greywater. Flat roofs offer a very viable way to add microclimates to a property, and well as offering water storage.

Considering alternative carbon-free building materials will be an inevitable change in the design of any building, domestic, commercial or industrial, but so will the way any of them uses energy, for heating manufacturing or general use, tv, cooking of just the internet.

For many of us, CPD is the key, to our involvement, learning in detail, how all that's highlighted in this article can be incorporated into our detailing and building design. The headlines and the keywords below might well be used as an agenda for research, I use Obsidian as my knowledge base, linking headlines to content, often from diverse links and articles. You might want to copy this entire article as a base article within Obsidian and start your own links.

The global spread of Covid should not be discounted in the climate change argument, its effects on life are now so high, businesses are being affected by lack of supplies, staff and distribution, although some see the global move from large offices to working from home as a major gain. But the knock-on effect to city centre supply businesses can easily be seen. The city centre is about to change.

We need a COP that has global action, not words and promises. ■