Smart Architecture in an Age of Climate Change and Mass Global Inequity

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Abstract

Housing in the pre industrial ages made use of local resources, such as stone, reeds, bamboo, timber, mud and even ice, along with human ingenuity, to come up with the best possible solutions to shelter from the prevailing climatic and geographical conditions. Our forefathers' abilities to develop innovative solutions is evidenced by the architectural marvels that still exist around the world today, particularly in the Middle East, the cradle of all human civilisation. No doubt the ages also saw many failures that did not stand the test of time and the changing planetary conditions, such as fires, floods and ice ages. Some of the successful designs exist to this day however, and are a testament to ingenuity, and skilled design and construction.

Heating or cooling of these pre fossil fuel houses required inspiration and initiative and local natural resources; this is also evidenced in the design of the great public buildings that have tended to stand longer than domestic housing.

Whether many people of these times were also homeless has not come down to us through the history books but certainly there were nomadic tribes eking out their living by following the seasons as well as disempowered people who were often enslaved as a by-product of war and who did much of the necessary domestic and 'commercial' work. These people however were likely housed in quarters that at least ensured their survival and fitness to work.

This paper explores what architectural lessons can be learned from the past to help free us from our mass dependence on planet-destroying fossil fuels for domestic heating and cooling as well as the issue of mass homelessness in an era when a family home has become a status symbol of the rich and is too often outside the financial means of most.

Further we espouse that proper design of homes can harvest renewable energy in sufficient quantities to feed back into the grid or to power extraneous human uses such as for powering electric cars and lighting and heating public and community facilities.

Key words: Smart architecture, climate change, fossil fuel, clean energy, homelessness, equity.

Introduction

Smart architecture should be adapted to time and place and provide domestic needs such as light, shelter from the extremes of temperature, a place of sanctuary and security and ideally should also have an element of aesthetic design to make habitation comfortable and pleasant. This should all be achievable through the design itself and incur no further construction costs and, ideally, minimal reliance on non-renewable energy.

Humankind began in Africa and over the centuries has spread out to occupy nearly all parts of the world, with Antarctica the only continent with no permanent human habitation. Until the Industrial Revolution (in the period from about 1760 in Europe and the US, to sometime between 1820 and 1840 in the rest of the world) examples of early housing, particularly in the Middle East region which saw the development of society and gathering of people and dwellings into our earliest towns and cities, by necessity, had to provide and meet all needs from the local environment. Due to seasons, latitude and topography however the local environment ranged and ranges from extreme cold to extreme heat, sometimes in the same location, and other geographically specific factors such as earthquakes, floods and wildfire which require smart design considerations.

Much work has been done previously on the lessons to be learned from Middle East, particularly from ancient buildings in modern day Iran, Jordan and Turkey, which provide excellent examples of classical smart design. (1,2,3,4)

Other global building material examples include ice in the Arctic, mud brick, (adobe, cob, Kahgel) in the Mediterranean regions and wood in Europe, Australasia, and North America.

Our time of climate change, extreme climate 'events' and "natural disasters" requires a new focus on how we can live comfortably without the proliferation of use of the fossil fuels which caused the current problems in the first place, and this, combined with a time of mass inequity and obscene levels of homelessness globally forces us to look both at our positive past achievements and towards the future.

Looking to the past

Architecture of ancient times, by necessity, used natural principles in regards to light, space, temperature, orientation, defence and aesthetics. (1,2,3,4). The Middle East particularly, is the region where humans started to gather together in larger numbers because communal living provided many advantages and at the same time eliminated many problems. It also provided larger communal workforces to build permanent domestic housing and public buildings along with communal amenities such as water storages, drainage systems and defence systems such as city walls.

Specifically construction in the Middle East saw the birth of many architectural designs that provided natural solutions to cater to the comfort and needs of domestic housing which are still used to this day. The courtyard or atrium houses of Islamic cities, the terraced dwellings of Afghanistan (5), shaft dwellings of Tunisia (5), each utilize differing connections between interior and exterior spaces together with variable relationships to the natural ground plane. The covered alleyways (Sabat) provided cool flows of air between abodes as did the positioning of the house or community among green spaces provide natural flow of air. Some houses were carved from the rocks or mountains themselves and others coned in shape (beehive houses) to cool them by expelling the heated rising air.

Sabat (covered walkway) in Yazd, Iran

"Beehive" houses in Syria

Iran's ancient ice houses which could keep ice frozen in deep cellars throughout the year

Kandovan Village near Tabriz in Iran

Wind catchers (Badgir) to provide a constant flow of fresh air and dispel heat were used extensively in the warmer parts of the Middle East. Cellars and subterranean rooms provided cool spaces for human relief and to preserve food and even ice in such early Iranian dwellings.

Courtyards in the Middle East and the Mediterranean regions of Europe, particularly Italy and France, provided a cool place for relaxation and for kitchen gardens and also provided pockets of cool air for a natural flow into adjacent dwellings. Ancient solutions and housing design managed to combine these property aspirations at least for the free classes.

Wind catcher, Yazd, Iran

Italian courtyard gardens have not changed over the centuries

Of course, people across the wider world were also developing their own solutions based on local conditions with the ice houses (igloos) of the Eskimos perhaps the most surprising and ingenious. Igloos had an internal temperature of 16 degrees centigrade by body heat alone while outside temperatures were as low as -45 degrees Centigrade (6). Now in Alaska people shiver in modern houses burning gallons of oil.

Other global building material examples include wood in Europe, Australasia, and North America which was a renewable resource before the great forests of the planet were decimated.

Walled cities in the Middle East and Castles in ancient Europe provided defence not just for the occupants in times of war and siege but often housed the entire local community and animals were raised, and crops grown, within their great walls. They were also located on hill tops to provide a commanding view on all sides and with lookout towers for defence purposes. Where this topography was not available water-filled moats were dug around them to slow down and disadvantage any invading forces.

Castle in Bam, Kerman province, Iran

Bamburgh Castle in the United Kingdom

Castle moat and drawbridge

Castles, of course, also provided the privileged classes with protection.

Homelessness and Inequity

In 2015, 150 million people worldwide were homeless and 1.6 billion people around the world lived in "inadequate shelter" (OECD 2015). This coupled with mass poverty, millions of refugees and the increasing trend of rural populations moving to large cities to seek work has seen housing increasingly become a 'luxury item' due to its high cost, and has thus created a major global problem. In far too many places in the world people literally have nowhere to go. We therefore need to acknowledge that everyone alive has the right to live somewhere and thus we need provide affordable housing, with a small footprint. Currently luxury housing takes up far more space than anyone requires, with multiple bathrooms and bedrooms and luxury items such as large gardens, pools, media rooms, gyms, spa pools and saunas.

While some countries are stipulating 'affordable housing options' in all new developments the simple fact is they are few and not readily affordable by those with the greatest needs. In the US, the "richest country in the world" roughly 1.1 million students, 114,659, (7) more than one in 10, were identified as homeless in the 2017-18 school year, according to data compiled and published by the New York State Technical and Education Assistance Center for Homeless Students. Oct 15, 2018. The number of Americans living in their cars surged 46 percent in 2017-2018 (CBS News, July 2018). This level of homelessness affects all aspects of people's lives and compounds their problems putting such people on an ever spiralling descent into destitution. This scenario is reflected in all countries of the world and is exacerbated by wars, dictatorships and natural disasters. An unprecedented 68.5 million people around the world were forcibly displaced at the end of 2017 (UNHCR).

Smart design in 2019 therefore also needs to address refugees, asylum seekers, mass homelessness and itinerant populations and the need for low rental subsidised or hire purchase accommodation that preferably also harvests its own renewable energy.

Some Islamic countries assist the poor to purchase houses via Islamic Finance and some nations build rent subsidised high rise accommodation but this is often a 'cheap solution' of poor design and with questionable safety standards.

Of course homelessness and poverty have always been related to a government's 'national priorities' – and thus is sway to national political ineptitude or injustice.

The problem is global and intensified by the fact that even in developing nations where humans may have once been able to erect a temporary dwelling and eke out their existence on common land, this land is now owned by the rich few and is being developed for non-housing purposes.

Today's architectural design too often ignores these needs and design of modern housing is and is centered around attracting as high a price as possible from the purchaser. House design too often tends to be what is coveted by the masses, and is personified as "McMansions" (a pun comparison with cheap and poor quality 'fast food'), which are energy inefficient (yet full of electrical 'time-saving goods') over lit, have a huge footprint and often built for a 2-4 person household, with multiple bedrooms, bathrooms and toilets, media rooms, spas and saunas, gyms,and so on.

Facing north or south to capture heat and light is currently less important than 'street appeal' which caters to human vanity only. Even the term, 'street appeal', places less emphasis on the actual dwelling and its design and more on price and vanity.

Applying past architectural techniques to modern living

Wind catchers to provide a constant flow of fresh air and dispel heat were used extensively in the warmer parts of the Middle East and modern forms are used today in places such as the northern states of Australia and the southern states of America, though the traditional wind catchers of the Middle East have been replaced with rooftop propeller fans that turn with the air flow and expel the warm air that has risen during the day. They are a common mechanical system globally and can reduce the need for cooling houses by fossil fuel generated Air conditioners.

Indeed the invention of air conditioners has caused the loss of many of these cheap and efficient designs. The wish to provide endless products for manufacturers to sell to home buyers has led to the loss of many cost free devices and these so called convenient modern alternatives, cost far more in the long run for the individual house owner and society as a whole.

Australia, a relatively new country of European settlers was in a position to adopt the best of earlier design that existed in the Middle East and Europe and early on decided on traditional approaches to domestic heating and cooling with good ventilation, roof top fans, shady verandas and proximity to green spaces. The original inhabitants of Australia, the aborigines, could arguably be regarded as the first environmentally friendly house designers as they created no permanent dwellings and put no scars on the landscape. Rather they were prepared to put up with some natural discomfort in their lifestyle which may be a good lesson in itself for all of us. Being at a consistent temperature for maximum comfort day and night is not necessarily healthy in itself and weakens the human body.

Climate Change and Global Warming

Additional to everyday domestic and seasonal concerns, global warming, and with it rising sea levels, extreme events and degradation of the environment all give rise to new problems and the need for new solutions. Major loss of the world's forests are increasing temperatures and causing a shortage of timber as rainforests are cut down for cattle grazing and palm oil plantations, both with their negative influences on human health. Clean water resources are being depleted or putrefied. Most major cities of the world will go (partially) under water on sea rise predictions making housing 'footprints' more relevant - i.e. more people will need to be squeezed into smaller areas.

The obvious disparity in affordability and non-affordability aside there are many more climate change factors to be considered. Loss of space and cost of footprint in cities (requiring high rise dwellings), putting housing estates on land desperately needed for agriculture, building in inappropriate areas such as seaside locations help litter the seas with plastics and poisons, as does the building on spaces that are becoming less safe for living, like flood plains. Climate change is contributing to desertification, more wildfires (California, Greece, Portugal, Australia) and floods (Iran, Turkey, SE Asia, European Countries, Australia). Housing loan providers and home insurers are now factoring climate change costs into insurance coverage, refusing lending, and more customers are defaulting on loan repayments and land and properties going into the coffers of the lending banks. The entire system is leading to the rich owning more of the land surface of the planet and the poor becoming increasingly homeless.

Effects of Hurricane Sandy in New York City in 2012, saw the sea invade the streets and suburbs. The New York Stock Exchange closed for two consecutive days. Major floods in Thailand have seen one third of the country under water. In 2019 floods in Australia killed 500,000 cows and caused the Flinders River normally several meters across to swell to 60 kilometres wide and could be seen from Space. Australia's regular floods have seen areas of land the size of France under water in Cyclone seasons.

Satellite image of flooded Flinders River, Queensland, Australia 2019

Jakarta in Indonesia, Bangkok in Thailand, and European cities and countries have seen massive floods in the past 10 years as has the United Kingdom. Many of the world's capital cities (often located on natural harbours), will go partially or completely under the sea.

Ethical issues

.In this overcrowded world the majority of people suffer injustice on many levels but homelessness is one of the more obvious and most basic needs not being met. Stone age man was arguably much better off than most humans in our modern times. Denial of climate change is yet another injustice and a cruel hoax on those who will suffer the consequences of it, by those who hope to gain personally from the disaster they have created. When did we collectively decide it was okay for huge number of humans to live on the streets with no facilities at all while 1% of human have multiple abodes, and personal golf courses?

Housing safety is an issue as well. Humans need a safe place to sleep at night under cover of the elements; a place to keep clean and a place to cook and eat. It seems that in the push to design mansions for the upper classes on productive and fertile scenic lands the basic needs of all are callously overlooked. Arguably, if every human just aspired to their immediate housing needs there would be enough money and land for all humans to be adequately housed.

A small and practical house can still be aesthetically pleasing without clever design, by the use of shape (angle), and effective lighting. Indeed a house that makes the best use of natural light, shade, and orientation provides the optimum aesthetic approach to housing. The new "Small Houses" manage to provide all human needs into a cravan size abode by clever design. Rooms and facilities and even stairs can be folded away when not needed.\

Fortunately some civil authorities are preparing Planning processes and quality codes for eco -houses and communities and architects are rising to the challenge.

An Eco-house is an environmentally low-impact home designed and built using materials and technology that reduces its carbon and actual footprint and lowers its energy needs.

Features depend on the locality and climate and could include some or all of the following:

- Higher than normal levels of thermal insulation
- Better than normal air tightness
- Good levels of daylight
- Passive solar orientation — glazing oriented for light and heat
- Thermal mass to absorb that solar heat
- Orientation — to reduce or provide heat loss depending on the hemisphere and the geographical locations.
- Mechanical ventilation with heat recovery (MVHR) system
- Heating from renewable resources (such as wind, solar, heat pump or biomass)
- Photovoltaic panels, small wind turbine or electricity from a 'green' supplier
- Natural materials — avoidance of PVCu and other plastics
- Rainwater harvesting
- Grey water collection and cleaning
- Composting toilet
- Glass that has two or three layers with a vacuum in between to prevent heat loss in cold areas; (double or triple-glazed windows) and windows with good ventilation for hot areas
- Solar panels or wind turbines
- Geothermal heating and growing plants on the roof to regulate temperature, absorb noise and to produce oxygen
- A vegetable patch outside the house for some food (8)

Energy Loss

Calculations on domestic home design energy loss indicate as much as 70% of all the energy used in the UK when all the factors are taken into account. This energy is mainly for heating and lighting and therefore the aim is to design houses that are well insulated and make the best use of natural light. (8)

Insulation

Increasing the amount of thermal insulation is the main component of preventing energy loss. This includes draft exclusion, glazing, and wall and roof insulation.

Passive solar gain

In the northern hemisphere, a south facing site will be a much better location than a north facing site (and the opposite in the southern hemisphere) because of access to sunlight and protection from the cold northerly wind. This of course also varies according to location and climate.

It's not always possible but there will usually be an opportunity to take advantage of the passive solar gain by having more glazing on either the front or the back of the building. Planting trees and creating wind breaks on appropriate sides of the site can enhance the solar gain effect.

Active solar gain, solar panels and domestic contribution to power grids.

High performance windows are used to draw in as much light and warmth as possible. Sunlight then floods into the house and any heat generated is retained by a highly insulated building shell, draught proof windows and doors and thermal mass within the building (8).

Orientation towards the sun also means that active solar systems can be fitted, both solar water heating panels and electricity generating solar panels on the roofs, further adding to the free heat and electricity gained from the sun.

Living gain

Living in a house also generates heat. Active human beings can produce as much heat as a one bar electric fire. (8) Heat from cooking, washing, hot water systems and lights contribute to how an eco-house can gain heat from natural innate sources.

Heat recovery ventilation

These systems extract the warm, moist air from bathrooms and kitchens and take the heat out of the stale, damp air before venting it outside. The heat recovery system transfers this collected heat to fresh air coming into the building and distributes it to where it is needed. An added benefit is that filters can be fitted on the air intake to provide a barrier to pollen or other irritants (8).

Living heat loss

With the passive and active solar gains, insulation, and a draft proofed building shell and heat recovery system, eco-houses can require zero heat. Such houses, even those built in the United Kingdom , properly oriented, can require no additional heat, even in winter. An eco-house can incorporate design to have heating systems that can react quickly and efficiently to any changes in room temperature as well as providing a heat boost to the water temperature down-stream of the solar panels (8).

Sustainable building materials

One of the wider issues of energy efficiency is the embodied energy within the construction materials.

Timber

Wood is a primary building material for eco-housing. This is because trees grow using energy from the sun, they don't pollute, they produce oxygen, absorb CO2, they provide a wild life habitat, they can be replanted, they can be sourced locally, the timber can easily be put to some other use after a building is demolished (8).

Lime

Lime has been used as a building material for thousands of years and although energy and CO2 are used in its production it gently returns back to limestone in time, taking in CO2 in the process (8).

R***eclaimed materials***

Use of reclaimed materials is ideal, particularly wood, bricks, slates and roof tiles, to make use of the embodied energy within these materials. (8)

Gardens and green spaces

Rooftop living areas and rooftop gardens provide insulation and cool paces as retreats and sources of cool air flows. Gardens or courtyard walls can also grow vegetables and herbs for those with minimal outdoor space and those without access to the ground.

Living with the seasons

For domestic dwellings in localities that experience great annual variation in temperature using the insulation principles is the best way to deal with changing seasons, i.e. keeping the heat in, or keeping the heat out.

Other design features

Load bearing internal walls can be minimised to allow rearrangements of the interior spaces, and the building technology be such that local trades can carry out alterations and easy maintenance using earth friendly, materials and processes. (8)

Health

Health benefits of an eco-house, apart from the obvious risk of planetary destruction due to human induced climate change, are a healthy living environment and planet. The heat recovery system can eliminate dampness and the moulds. Air intake filters prevent dust coming in with the incoming fresh air and internal vacuum cleaner system can extracts dust from the house.

For the health of the householder, and the planet, an eco-house should be built with materials that are free, wherever possible, from toxins or harmful products of the petro-chemical industry.

On a wider view of health effects, modern day farmers are becoming stressed and depressed from facing endless natural disasters brought about by events caused by climate change, that kill their livestock, create droughts and reduce the income from once viable farms.

Health benefits from smart design

- Reduce inside pollution through proper ventilation

- Provide heat/warmth that provides continuous natural heating and maintains air ventilation rather than capturing warm air that is continually recycled (carbon monoxide build up)

- Avoid or reduce pestilence (screening to keep out dangerous insects such as mosquitos) and vermin (rats, mice, cockroaches)

- Non toxic materials and environments

- Provide cool in hot locations and hot seasons

Pollution

Air pollution is a global problem exacerbated by populations moving to major cities. The world's two bigegsty polluters are China and the US. Various forms of pollution have increased as China has industrialised, which has caused widespread and serious environmental and health problems. High levels of air pollution in China's cities cause 350,000-400,000 premature deaths per year.

Forty-three percent of Americans live in places where they're breathing unsafe air, according to American Lung Association (9). An increasing number of Americans live in places with unhealthy levels of smog or particulate air pollution – both of which are being made worse by climate change, according to a new report. (9)As temperatures rise, wildfires are becoming worse and spewing smoke across the west of America. More smog, or ozone, is forming on warmer days.

For the three hottest years on record, 2015 through 2017, about 141 million people lived in US counties that saw unhealthy levels of particle pollution, either in a single 24-hour period or over a year, or unhealthy levels of smog. (9)

In Paris and London summer heat related deaths have been due to poor building design.

In 2003, more than 70,000 people across Europe died in a sweltering heatwave that spanned much of the summer. Many of the apartments were built for times when the climate was cooler and had no proper ventilation. In many such abodes windows could not be opened. (10)

France was among the worst-affected countries, with 15,000 deaths in August alone. In the UK, the summer saw more than 2,000 heat-related fatalities.

The World Economic Forum on the Middle East and North Africa report on the consequences of climate change across the Middle East, and extends from widespread floods in Turkey and Iran in 2019 and increased daily temperatures make outside living impossible during the day in the Gulf countries. Rising sea levels are putting many coastal cities at risk. In Alexandria, on the Mediterranean coast of Egypt, as sea levels rise, the city of five million people is sinking. The Nile Delta, on which Alexandria stands, is shrinking. Construction of the Aswan High Dam and the extraction of water upstream has reduced the Nile's flow, decreasing the amount of silt the river deposits. And without silt to replenish delta soils, the whole area is vanishing (11).

Global warming causes particular problems for the Middle East region. Huge dust storms that sometimes used to plague the Gulf countries are becoming more frequent and more widespread. They extend to Eastern Iraq and Western Iran as well as Kuwait and northern Saudi Arabia. As well as heart and lung problems in people they have a negative impact on economies and close down airports.

The World Bank declared in 2016 that the MENA region is among the most vulnerable places on earth to rising sea levels (12).

Aesthetics

A heartening quality of humanity, is the love of art, design and architecture which entails shape, decoration and the play of light and angle. The need for 'smart architecture' to solve problems of use of fossil fuels (non renewable energy) will actually provide better aesthetic design (light and shade, orientation) than the high rise boxes heated and cooled artificially that provide mass housing currently.

Location

Proper climate defence as regards location not only looks at seasonal variation but long cycles of variation. Nature and Climate caused disasters and cyclical events include cyclones, floods, wild fires, and earthquakes which can occur over series of years.

Floods

In Queensland Australia in cycles ranging from 3 to 15 years much of the state (e.g. an area of land the size of France), can be under flood waters. This is happening more frequently, indeed often annually, as climate change takes its hold.

The earlier floods led to the design of "The Queenslander" a house which was built on stilts with the house on the first floor allowing it to stand clear of flood waters. In normal non-flooding seasons the house was also cooled by the under house air flow. Wide verandas that stretched around the entire house also kept living quarters in shade throughout the day and provided a natural breeze. A central hallway, opening at both ends of the house is a feature of most Australian houses in hotter areas.

A "Queenslander" in normal season

A "Queenslander" during flood season – the house itself sits high above the flood waters

In southern states of Australia, Greece and California climate change has already arrived causing summer wildfires destroying homes and livelihoods. Australia has seen an endless cycle of fire and building regulations and requirements have seen necessary major changes in building design and safety.

Earthquakes

Earthquakes in Kobe in Japan (1995) and Bam in Iran (2003) saw the destruction of homes and mass civilian deaths. Japan has now brought in Earthquake Resistant Structures. These are now the most common structures for detached houses in Japan. All buildings built after 1981 must conform to the New Anti-seismic Structure Standard requiring buildings to have an earthquake resistance structure.

The earthquake in Bam, Iran in 2003 was caused by a rare geological feature, a concealed fault line that was invisible on the surface.

The Fukushima earthquake caused a tidal wave which displaced 50,000 households after radioactive material leaked into the air, soil and sea after a 15-metre tsunami disabled the power supply and cooling of three Fukushima Daiichi reactors, in March 2011.

China, Russia, Japan, South East Asia, Australia and North and South America are on the Pacific Ring of Fire therefore earthquakes are an ongoing concern for all of those countries, as well as Iran, Kashmir, Pakistan, India, Nepal which are on the tectonic plate pushing up the Himalayas.

Floods due to global warming have also seen an increase in land slips and mud slides due to heavier rainfall in shorter periods of time and while damage from large slips cannot be dealt with through smart design, small localised land slips is also a consideration in building design and location of dwellings. Reforestation on slopes that were once protected by forests is an obvious remedy.

Human influence

Population growth and population density and the trend to move towards cities, means decentralisation must become a focus, as it has in various countries in the past, not just to reduce the need for ever increasing infrastructure but for safe, healthy living environments. The issue of population growth on an already overcrowded planet is an issue in itself. It may be time that we all address just what are we doing here on this planet and what are we trying to achieve, other than the wish to stay alive in our own life-spans. We have the intellect to look further and consider the responsibilities of our guardianship of planet earth.

The main bases of smart architecture should entail domestic housing sufficient to provide basic human needs (cultural and social justice) and economic and environmental sustainability. How can these aims be achieved?

Houses generating their own energy

There are so many local renewable energy options and architects and designers, being local resources themselves, should base their designs on the locality and the best use of sustainable energy to power the dwellings.

While solar power is not an option for all parts of the world Australian uptake of rooftop solar panels provides an excellent feasibility study. Due to high usage, Australian houses with solar rooftop panels are not only generating all domestic energy requirements but are putting surplus back into the grid and being paid for it. This domestic generation of energy can then be used to power other domestic needs such as electric cars, home businesses, farms and street lighting.

The theoretical economic implications of this are that the in-built generation of energy can be put toward cheaper, energy-neutral housing via government subsidies and fully subsidised housing for the homeless. The economic advantages on the domestic and national scale are enormous and populations with proper homes and addresses can create a wealth source for countries that take care of their poor and dispossessed.

Collecting, Cleaning and recycling water

In the past, houses that were not adjacent to clean water sources, collected their own from rain on rooftops and other runoff areas. This rainwater collection disappeared in cities but is now making a necessary comeback in some places. In 2018 Cape Town, South Africa entirely ran out of water and many global cities now have to ration daily water usage due to short supplies. This is due to increasing scarcity of clean water resources at the same time as increases in population.

Modern architects are now factoring water usage into their designs for commercial and domestic buildings. Commercial buildings can recycle grey water for toilet flushing or provide small wetlands within the building footprint to clean water waste and return it to the system. These same wetland areas provide attractive green spaces and reduce heat. Recycled water provides substantial cost saving for the owners as well as energy saving for the community.

Public housing to overcome homelessness

The main cause of homelessness and poverty is government inactivity. This is also poor economics as homelessness and poverty deplete a country's productivity. Currently where it is available and affordable little thought for safety and aesthetics has gone into the design of public housing. The Grenfell Towers fire in London in 2017 provides a lesson in poor design with flammable exterior cladding providing insulation – likely cost effective in the construction phase but stupid, indeed negligent, when it comes to occupant safety and longterm viability of the dwelling itself.

The role of Town Planning Boards and Government Departments

Over the twentieth century building design and construction in advanced nations became increasingly regulated and in the 1990s, after the Rio Earth Summit, ESD (Ecologically Sustainable Development) was added onto other planning and design requirements.

The proportion of total energy use attributable to buildings generally ranges from 10 - 15% in undeveloped countries to more than 40% in the developed countries. In the UK, building use currently accounts for 46% of total energy consumption and it has been calculated that this energy could be almost

halved if the existing building stock were adequately insulated (3,4). This is a lesson in itself. The developed world is using energy wasting devices that are easily done without in developing nations.

In Iran statistics show that buildings account for about 39% of total energy consumption so once energy efficient design is now being replaced with energy wasteful design (3,4).

According to a report in "The 2nd conference of Fuel Conservation in Buildings" in Tehran (2003), the amount of energy consumed in buildings in Iran is equal to 30% of its annual oil income (equivalent to US$15 Billion in 2005), with 50% of this being wasted (3,4).

Experiences in several countries have shown that heat-related deaths are largely preventable through appropriate planning, communication and prevention, mainly via heat prevention plans (13). For long-term prevention of urban heat islands, a range of measures could be implemented in identified areas. Protective measures rely on accurate knowledge of surface properties and physical processes that generate urban heat islands so urban heat monitoring and air quality by relevant authorities , such as the Environment Protection Agency (EPA) in Australia needs to be implemented. Cities are always hotter than adjacent landscapes due to decrease in evaporation, anthropogenic heat emission, and heat retention within buildings and absorbed by road surfaces. Research in the Paris region showed a strong negative correlation between summer afternoon temperatures and vegetation index and a 0.2°C decrease per unit of vegetation index during the heat wave (13). Evapo-transpiration from vegetation in green spaces decreases temperature. Shadowed surfaces can be cooler by 11–25°C compared with those exposed to sun (13).

Roofs covered with selected white paints or highly reflective materials (cool roofs) reduce heat in the buildings below. During a heat wave, such properties enable these roofs to cool off by 28–33°C [14].

Tree planting in open green spaces and green roofs and 'plant walls' reduce pollution and temperature. Cool pavements, created using new technologies, are also being tested in some cities; for example, light-coloured porous concrete allows water infiltration, enhances water evaporation, and partly reflects solar radiation. (14).

In regard to the link between indoor and outdoor temperature, a study conducted in Montreal in 2005 on 75 apartments showed linear relations between outdoor air, surface temperature, and indoor temperature. Indoor temperature was highest in big buildings, which should obviously be the initial target for preventive measures (13).

The human element in adaptation to a changed climate

Society in developed nations seems to have lost or forgotten basic practices to keep both themselves and their dwellings cool. The expectation that there is a machine to do everything at the touch of a button requires an element of re-education, especially if these expectations are destroying life on the planet.

The historic willingness to modify behaviour and alter expectations has diminished with the wide spread introduction of air-conditioning and artificial heating and with it the knowledge of ways to deal with weather extremes is being lost. Even existing knowledge is becoming out of date due to prolonged periods of hot weather. Nguyen et al (2010) investigated the likelihood of increased hot days and hot spells for different locations in Australia and found that the longer the hot spell the more cooling required. A 3-bedroom house required 32% more cooling energy during a 4-day hot spell than for 4 individual hot days (15).

Building Codes are currently based on historical weather and climate data and need to be reviewed and updated. Most Building Codes deal with new buildings and it is existing buildings that pose the greatest problem as they are not required to keep abreast of modern building requirements and legislation. New Building Codes that require planet friendly techniques and materials must be instituted for new and old properties.

Governments need to both accept the science of climate change and to provide budgets to institute preventive measures as well as measures to ameliorate the results of climate change and global warming on their national populations. Assistance to do so should be given to those in great need.

Countries must move urgently to the use of renewable energy. For those countries whose economy currently relies on the sale and use of non-renewable dirty energy it would be wise for them to invest in the sciences of renewable energy and maintain and improve their economies and trade that way.

Population Aging and the vulnerability of the elderly during heat waves must be considered.

Little research on the changes in disease spread and disease patterns due to climate change seems to have been considered.

It is also predicted that the proportion of lone person households or nuclear family households will continue to grow in most countries. In Melbourne Australia for example, one or two occupants per dwelling will account for 90% of all new households by 2030.

Design of all domestic appliances should be reviewed and replaced with power efficient and clean technology.

Many of these measures listed above will generate growth and improve and stimulate economies and the health of humans and their environment. Populations already suffer due to the crippling cost of energy needs. We are currently dealing with the legacies of practices born centuries ago and we must look at the future with fresh eyes and take responsibility for our footsteps on planet earth. It is within the scope of humans to do so and will hopefully lead to a fresh approach to our collective humanity and put an end to the outdated political and industrial ideas that have brought the earth to its knees.

Ethics

Why do we currently have such energy inefficient modern housing? Sadly much of the inefficiency in building construction comes down to short term economic and political influences. The petroleum companies, huge electricity companies, building magnates and consortiums lobby governments for short term financial gain. The political classes, particularly in a time of mass extinction, looming mass starvation and collapse of entire planetary ecosystems should be looking past such immediate expediency and budgetary considerations to long term gain. Worse, too many of today's politicians tend to be born of the classes doing the damage in the first place.

Immediate major effort in tackling Climate Change is required as it will not only affect domestic housing and homelessness it will also create mass starvation as the seas become acidic and food sources die; the land will suffer desertification, clean drinking water and water for agriculture will dry up in some places and cause massive floods in others.

Building design will not provide all the answers but as it is very much tied to how humans live and work on this planet and thus a major focus on the issue can reap many rewards and set an example. In looking at these issues the re-design of domestic housing and urban streetscapes can also benefit the other major problems on homelessness and inequity. In a way such 'smart architecture' could solve many of the world's problems. Construction of new affordable housing that can feed energy back into the grid can finance the cost of building it in the first place.

A combination of building design that incorporates any renewable energy generated by sun, wind , hydro, waves, thermal masses, geothermal activity can theoretically be achieved in most places on the planet and where there is an oversupply savings and reduction in use of fossil fuels can be made in a secondary fashion and in this way the home can provide the full family domestic power needs.

Forests need to be protected to supply timber and to clean the air and to reduce carbon dioxide harm to the planet and humans, so until forests are restored we need to look to recyclable non- polluting construction materials.

With clever design it is possible to run an entire country on renewable energy generated by smart architecture and smart engineering, and in doing so, new aesthetics of clean and clever design and technology are born.

We also need national priorities to change. Poverty and homelessness are always an outcome of governmental policy that has a lack of focus on the welfare of the people. People who are a country's most valuable resource must be respected at the very heart of each human activity and system.

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