THE CONSTRUCTION INDUSTRY AND CLIMATE CHANGE

TEACHERS' GUIDE

sustainability for seychelles

Foreword

Climate change is now recognised as one of the major problems that the globe faces today. With the pace at which climate on our planet is changing, humans will not have the time to evolve in order to survive the change. Human beings, as a species, is being threatened, and unless we seek out ways to mitigate climate change, or adapt to its consequences, we, and the whole planet, stand to suffer. Underlying the need to mitigate and adapt, is a need to be informed, and be conscious of our contribution to the issue. From there, we can work towards a more sustainable future, for the human species, and other beings that live on Planet Earth.

As such, the reality of global climate change lends increasing urgency to the need for effective education on earth system science, as well as on the human dimensions of climate change. Interwoven with this fact is an urgent need for education to become an essential component of the Seychelles' response to climate change. As a result, local NGO, Sustainability for Seychelles, in collaboration with the British Foreign Office and the European Union, have produced a curriculum guide for post- secondary students and teachers.

This curriculum guide is designed to draw attention to the themes expressed above. It is divided into five sections, in which students learn about climate change itself, how it affects agriculture as well as how agriculture contributes to it. Students will also acquire knowledge and skill as to how the agriculture sector can mitigate and adapt to a changing climate. Some of the ways in which the sector can become more sustainable is also explored. Finally, the guide presents several different examples of activities that could be used to engage students in learning about these different themes.

The document is focused on developing educational materials for students and lecturers of the Seychelles Institute of Technology. The elements of this curriculum have been tailored to meet the specific needs of the institute and that of the construction industry in general. I hope that much can be drawn from it.

Acknowledgements

I wish to thank the NGO Sustainability for Seychelles (S4S), the Ministry of Education and all lectures who contributed in one way or another to make the guide a success.

Produced by Sustainability for Seychelles

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CONTENT PAGE

What is climate change?	4
Climate Change and its effects on the construction industry	8
How the construction sector contributes to climate change	10
Mitigating and adapting to climate change	15
Sustainable Construction	21
Learning Activities	25

SECTION 1:

WHAT IS CLIMATE CHANGE?

The average pattern of weather, called climate, usually stays pretty much the same for centuries if it is left to itself. Climate patterns play a fundamental role in shaping natural ecosystems, and the human economies and cultures that depend on them. But the climate we've come to expect is not what it used to be, because our climate is rapidly changing with disruptive impacts and that change is progressing faster than any seen in the last 2,000 years.

Scientists have pieced together a picture of Earth's climate, dating back hundreds of thousands of years. The historical record shows that the climate system varies naturally over a wide range of time scales. So, Climate change itself is not new.

Annually, more than 60 percent of global industrial carbon dioxide emissions originate from industrialized countries.

In terms of historical emissions, industrialized countries account for roughly 80% of the carbon dioxide build up in the atmosphere to date.

The Earth is some 4.5 billion years old and during those years there have been significant changes in climate. The causes of these changes were decidedly natural and not caused by humans since the influence of early people was very small at that stage. In general, climate changes prior to the Industrial Revolution in the 1700s can be explained by natural causes, such as changes in solar energy, volcanic eruptions, and natural changes in greenhouse gas (GHG) concentrations.

Photo: Volcanic eruption Source: : universetoday.com

Photo: Sand storm source: wohba.com

Anthropogenic climate change and global warming

Recent climate changes, however, cannot be explained by natural causes alone. Research indicates that natural causes are very unlikely to explain most observed warming, especially warming since the mid-20th century. Rather, human activities can very likely explain most of that warming. In other words, up until the last century, humans have been accelerating the rate at which the Earth's climate changes and this is known as **anthropogenic climate change.**

Anthropogenic climate change is caused by the release of extra greenhouse gases by humans at rates with which the Earth's atmosphere cannot keep up. As a result, these greenhouse gases built up in the Earth's atmosphere, and act as insulation around the earth's atmosphere.

In this way, the gases prevent much of the Earth's heat from escaping, leading to a gradual increase in the Earth's temperatures. This is called the **enhanced greenhouse effect,** more commonly referred to as **global warming.**

Photo: Deforestation
source: worldwildlife.org

Photo: Processing factory
source: abc.net.au

Photo: Vehicle exhaust fumes
source: autoextract.co.uk

Why do we use the term 'enhanced' when talking of the greenhouse effect?

This is because greenhouse gases are also released naturally through the eruption of volcanoes or the decomposition of vegetation matters. This natural greenhouse effect has been beneficial, allowing temperatures to remain high enough for the Earth's current life forms to develop.

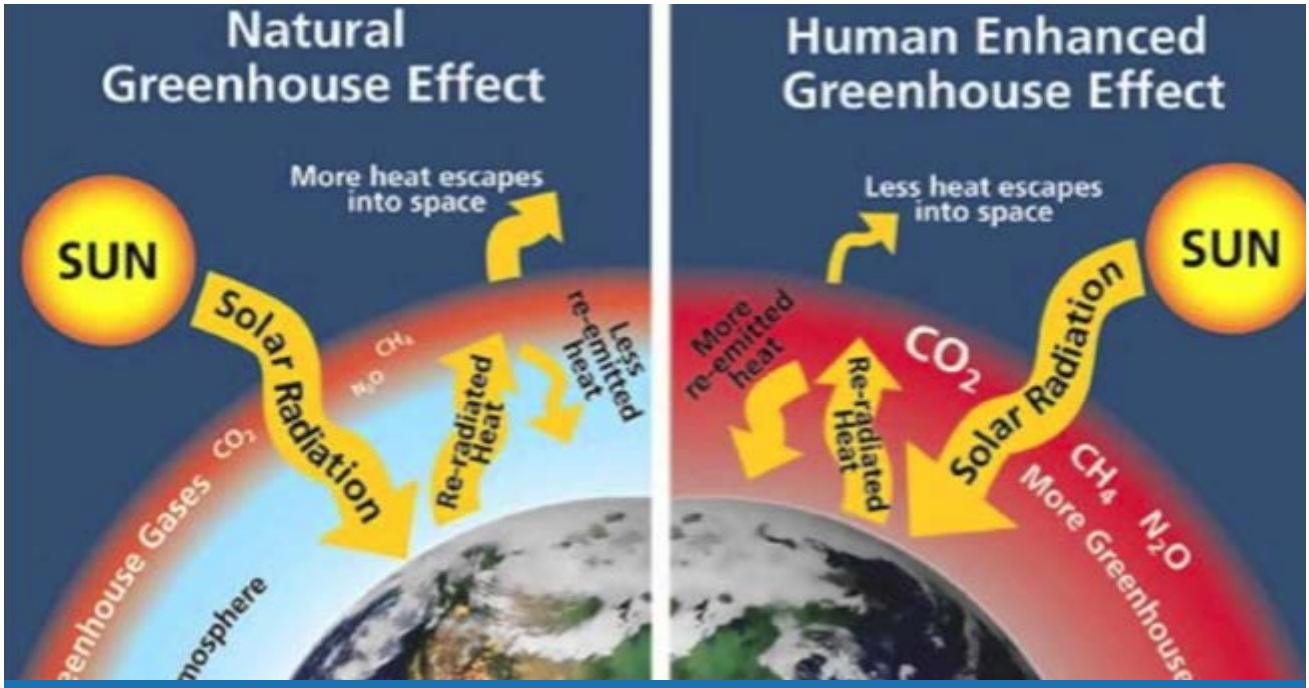


Diagram: The Natural and Enhanced Greenhouse Effect

As a result of the increasing concentration of these gases, more longwave radiation from the Earth is absorbed, thus reducing the energy lost to space and so altering the natural balance between incoming and outgoing radiation. Continued use of carbon-based fuels will further increase the atmospheric concentrations of carbon dioxide and other greenhouse gases.

Rising levels of carbon dioxide and other greenhouse gases in the atmosphere have warmed the Earth and are causing wide-ranging impacts, including rising sea levels; melting snow and ice; more extreme heat events, fires and drought; and more extreme storms, rainfall and floods. These are what constitute a changing climate!!

Scientists project that these trends will continue and in some cases accelerate, posing significant risks to human health, our forests, agriculture, freshwater supplies, coastlines, and other natural resources that are vital to state economy, the environment, and our quality of life.

Since the start of the industrial revolution vast quantities of carbon dioxide and other so-called greenhouse gases have been released into the atmosphere by the burning of fossil fuels, most notably coal and oil, and to a lesser extent, gas. This has led to an increase in the atmospheric concentration of carbon dioxide from 280ppm (parts per million) to its present level of 355ppm. Carbon Dioxide is one of the main greenhouse gases, along with water vapour and methane.

Effects of climate change

Some effects of the warming planet are already being felt, and further consequences are on their way. These changes will vary from region to region, but general trends include:

- changing precipitation patterns and heavier downpours, even in areas where overall precipitation will decline;
- longer, hotter, and more frequent heat waves;
- rising sea levels due to melting glaciers and land-based ice sheets;
- loss of both sea ice and protective snowpack in coastal areas;
- stressed water sources due to drought and decreased alpine snowfall;
- "positive feedback loops"—consequences of warming that cause further warming, such as melting sea ice decreasing the capacity of the northern oceans to reflect solar radiation back out of the atmosphere.

Whilst we have no control over the natural causes of climate change, we have direct influence over the human causes of climate change.

Greenhouse gases are produced by human activity, including:

- burning fossil fuels
- using energy generated by burning fossil fuels
- some aspects of farming, such as raising cattle and sheep, using fertilisers and growing some crops
- clearing land, including logging
- breakdown of food and plant wastes and sewerage
- some industrial processes

The main greenhouse gases generated by human activity are carbon dioxide, methane and nitrous oxide and some manufactured gases such as chlorofluorocarbons (CFCs), halocarbons and some of their replacements. Water vapour is also a powerful greenhouse gas but the amount in the atmosphere is not directly linked to human activity.

TOO MUCH OF THE GREENHOUSE GASES CAUSE THE EARTH'S TEMPERATURES TO RISE FURTHER TO LEVELS THAT MAY BE POTENTIALLY DANGEROUS FOR EARTH'S LIFE FORMS.

Almost 100% of the observed temperature increase over the last 50 years has been due to the increase in the atmosphere of greenhouse gas concentrations like water vapour, carbon dioxide (CO2), methane and ozone. The drastic increase in the emission of CO2 (carbon dioxide) within the last 30 years caused by burning fossil fuels has been identified as the major reason for the change of temperature in the atmosphere.

Reducing Climate change and the Carbon Footprint

More than 80% of the world-wide energy demand is currently supplied by the fossil fuels coal, oil or gas. 72% of the totally emitted greenhouse gases is carbon dioxide (CO2). When you drive a car, the engine burns fuel which creates a certain amount of CO2, depending on its fuel consumption and the driving distance. When you buy food and goods, the production of the food and goods also emitted some quantities of CO2.

Climate change concerns all of us. Scientists believe that the rate at which the Earth's climate is changing can be slowed down, if each of us can make an effort to reduce the amount of carbon dioxide gas we directly and indirectly release into the atmosphere.

Your carbon footprint is the sum of all emissions of CO2 (carbon dioxide), which are induced by your activities in a given time frame. Usually a carbon footprint is calculated for the time period of a year.

Basically, a carbon footprint is a measure of the impact that human activities have on the environment in terms of the amount of greenhouse gases (GHG) produced, measured in units of CO2.

What goes into calculating the carbon footprint? Required data typically includes: on-site energy use of oil and gas, vehicles usage, electricity usage, how much recycling you do etc.

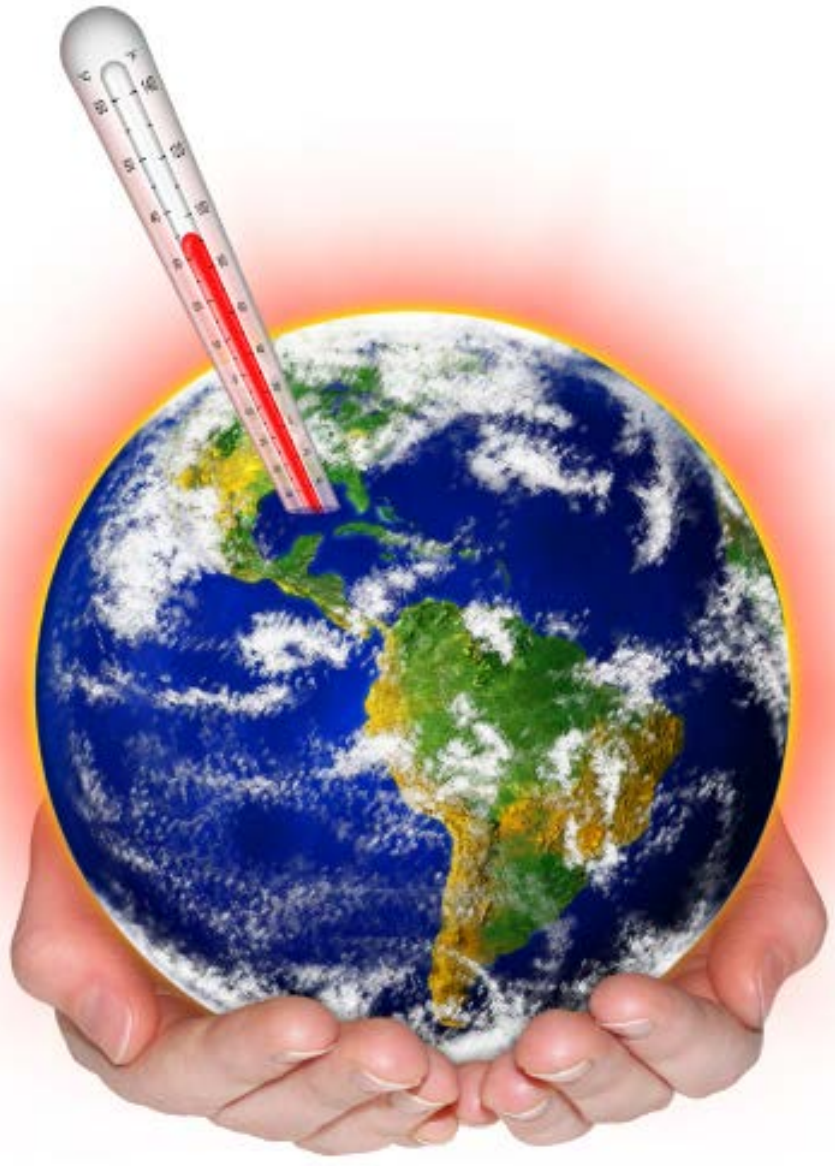
Sustainable living……..

Climate change concerns all of us. The rate at which the Earth's climate is changing is alarming, and according to climate scientists, if it does not slow down, every human being's future will be jeopardised.

Sustainable living rests on the fact that each and every individual can engage in reducing the amount of GHG-emitting activities that they are involved in, in order to prolong the life of planet Earth, so that in the end, future generations can have a planet to call home.

SUMMARY

- Our climate is rapidly changing with disruptive impacts, but Climate change itself is not new.
- Climate changes prior to the Industrial Revolution in the 1700s can be explained by natural causes, however, up until the last century, humans have been accelerating the rate at which the Earth's climate is changing.
- The release of extra greenhouse gases by humans act as insulation and trap heat near the Earth's surface, causing temperatures to rise: Global warming.
- Some effects of the warming planet are already being felt. They constitute a changing climate and include changing precipitation patterns and heavier downpours, even in areas where overall precipitation will decline; longer, hotter, and more frequent heat waves; rising sea levels due to melting glaciers and land-based ice sheets, etc.
- Your carbon footprint is the sum of all emissions of CO2 (carbon dioxide), which are induced by your activities in a given time frame.
- Mitigating and adapting to climate change relies on each individual person adopting a more sustainable way of living.



SECTION 2:

CLIMATE CHANGE AND ITS EFFECTS ON THE CONSTRUCTION INDUSTRY.

The construction industry is important in the economy of every nation as it contributes to the process of development. The construction industry comprises a wide range of businesses involved in engineering standards, building design, and the construction of various types of materials and structures.

This sector is affected in many ways by climate change. Knowledge about short term weather and longer term climate conditions are essential to adequately design and successfully manage construction projects. When we can no longer predict weather or climate, then construction can be heavily affected.

source: ec.gc.ca

Climate change may affect the construction industry through a range of biophysical and socioeconomic impacts. Generally speaking, it makes the planning process and physical location of infrastructure an even more critical issue than it used to be.

Long term climate impacts, such as sea level rise, coastal erosion, and drought, and short term weather related impacts, such as high winds and flooding influence the choice of site construction, building techniques, and materials for construction. The potential risk of severe weather and climate conditions also influence planning and project completion timelines.

- ***Choice of site location***
  Climate change events such as sea level rise, drought, and increased incidence of flooding can greatly influence the choice of site location. Sea level rise and flooding events can deter the development of low lying or coastal areas. Construction may then be concentrated on higher, often steeper elevations, with disastrous effects on the environment.
- ***Damage to, and destruction of, buildings and infrastructure***
  The increased frequency and severity of extreme weather events has the potential to damage, destroy, or severely impair the operation of the construction industry. Buildings may be damaged or even destroyed by the effects of extreme weather events and natural disasters.
- Buildings may become less comfortable as spells of extreme temperatures become more frequent or severe. They could also suffer accelerated degradation if changes in air pollution patterns increase their exposure to agents that may potentially be harmful to the building material such as acid rains.
- Construction projects that require dry conditions, such as laying roads or foundations, may be delayed indefinitely if there are floods due to heavy rain until the weather subsides. This can cost contractors thousands of dollars/rupees per day, if not properly planned for in advance.

Source: Upload.wikimedia.org

source: Upload.wikimedia.org

The soil will have to be drained first so as to be able to place concrete and allowed to dry. This will involve more resources such as pumps, and thus more energy and time waste. Also, in a muddy type of soil, the foundations will be deeper until a hard rock surface is reached. This is to prevent the building from dropping inside the ground. This will in turn use more machine and man power and also more concrete.

- ***Temperature increase***
  Increases in temperatures will greatly affect the comfort of people using buildings. Air conditioning costs may increase for existing buildings, but for buildings yet to be build, an increase in temperature may signify tighter legislation that impose building designs and orientation that may help in keeping the building cool.
- ***Precipitation changes***
  Increases or decreases in precipitation amounts in the tropics, especially in Seychelles, may greatly affect the design of foundations and basements as well as rooftops. Even plumbing designs may be affected. Perhaps a decrease in rainfall amounts may necessitate connection of all dwelling homes and office buildings to a rainwater harvesting system. As such, changes in precipitation levels associated with climate change also have the ability to influence building design. Furthermore, increases in the incidence of rainfall can lead to severe flooding events in some parts of the tropics, which may cause extensive damage to buildings and other infrastructures. Moreover, the weather conditions may affect the transportation of materials on site.
- ***Relative humidity***
  Changes in relative humidity have the potential to affect condensation, and associated mould growth. Buildings may become covered in moss due to high relative humidity, and contractors may need to find a way of adapting to this in their building design. One way of adapting to this in Seychelles is seen in the example where tiles are used on the outside walls of buildings, instead of paint.

HEALTH & SAFETY

Climate change, causing difficult weather conditions might surely be hazardous for the construction industry workers. The weather conditions such as heavy rainfall, high wind raffles or even high heat may cause injury due to slipping or hyperthermia. Other consequences of climate change are flash floods. These may occur in matter of seconds and construction sites being open, there is a high risk of damage to labour and plant. Changes in temperature may also increase wear and tear of equipment, due to expansion and contraction and also cause timber weathering. Scaffoldings may become a high risk factor in that case.

FINANCIAL ASPECT

The above mentioned problems eventually lead to delays in the construction process. Every project has to meet given deadlines. Any additional delays will lead to penalties in the form of fines, especially in government projects and other big projects. Not to mention that there will be the cost of labour and non-functioning equipment added to the bills.

SUMMARY:

- Key impacts of climate change on construction
- Weather related impacts: flooding, coastal erosion, subsidence, drainage systems requirements, new building techniques and materials to withstand adverse weather conditions; influence the choice of site
- Costs or finance/insurance: Insurance sector beginning to insert impacts of climate change into premiums. Sector has yet to put systems into place to discount climate-change related risk mitigation, but could be pushed to do so through building industry initiatives.
- Business interruption from wetter seasons.

KEY RISKS

- Reduced raw materials (if quarries are not rehabilitated)
- Regulatory risk in EU (emissions, building specs, environmental protection, planning etc)
- Rising power prices
- Rising cost of construction due to delays
- Emerging market competition
- Less space available for development
- Reputation risk/ NGO backlash for laggard companies

SECTION 3:

HOW THE CONSTRUCTION SECTOR CONTRIBUTES TO CLIMATE CHANGE.

Construction industry contributes significantly in terms of scale and share in the development process for both developed and developing countries. The construction products provide the necessary public infrastructure and private physical structures for many productive activities such as services, commerce, utilities and other industries. The industry is not only important for its finished product, but it also employs a large number of people (directly and indirectly) and therefore has an effect on the economy of a country/region during the actual construction process.

As with many activities undertaken by humans, the construction of buildings and other infrastructures has many impacts on the environment and contributes enormously to climate change.

Fact: construction accounts for 19% of global GHG emissions

Although construction practices typically do not produce large quantities of GHGs compared to the operations of many other sectors, the sheer number of construction projects results in significant aggregate emissions for the sector. For the construction industry, the two major sources of emissions relate to fossil fuel combustion, primarily from construction equipment, and fuel use from electricity used to power the equipments.

source: rocainjurylaw.com

KEY IMPACTS OF CONSTRUCTION ON CLIMATE CHANGE – SOURCES OF GREEN-HOUSE GASES:

1. The mining and manufacture of materials and chemicals.

This represents the source of highest impact. The mining and manufacture of materials proves to be a very energy-intensive and water consuming activity. The mining and metals industry is responsible for more than 20% of global emissions of greenhouse gases (GHGs) since it is estimated that the industry consumes about 10-20% of fossil fuels.

This consumption occurs in the use of machinery and processes for mineral exploitation, and also occurs with intensity during refining and processing of minerals. Metallurgical smelters require large amounts of energy in the process of moisture removal (drying), heating of ores (roasting), melting, recrystallization, distillation, electrolysis, among others.

Sources: cladyquarries.com

The manufacturing of cement accounts for 5% of global man-made CO2 emissions.

DID YOU KNOW?

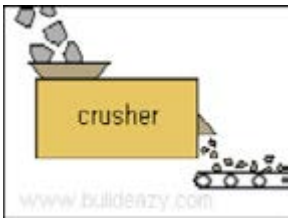
Cement is a fine, soft, powdery-type substance. It is made from a mixture of elements that are found in natural materials such as limestone, clay, sand and/or shale. Four essential elements are needed to make cement. They are Calcium, Silicon, aluminium and Iron.

Calcium (which is the main ingredient) can be obtained from limestone, whereas silicon can be obtained from sand and/or clay. Aluminium and iron can be extracted from bauxite and iron ore, and only small amounts are needed.

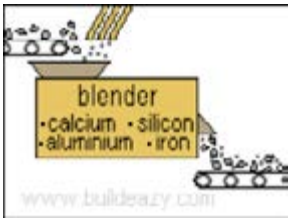
HOW CEMENT CAN BE MADE:

1. Limestone is taken from a quarry.

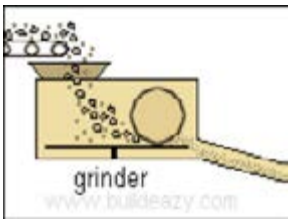
2. Boulder-size limestone rocks are transported from the quarry to the cement plant and fed into a crusher which crushes the boulders into marble-size pieces.



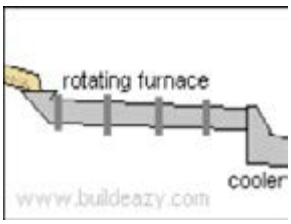
3. The limestone pieces then go through a blender where they are added to the other raw materials in the right proportion.



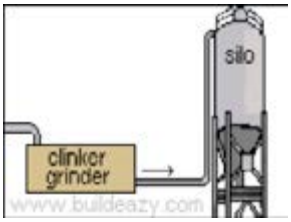
4. The raw materials are grounded into a powder. This is sometimes done with rollers that crush the materials against a rotating platform.



5. Everything then goes into a huge, extremely hot, rotating furnace to undergo a process called “sintering”. Sintering means: to cause to become a coherent mass by heating without melting. In other words, the raw materials become sort of partially molten. The raw materials reach about 2700° F (1480°C) inside the furnace. This causes chemical and physical changes to the raw materials and they come out of the furnace as large, glassy, red-hot cinders called “clinker”.



6. The clinker is cooled and ground into a fine gray powder. A small amount of gypsum is also added during the final grinding. It is now the finished product



FACTSHEET: THE CEMENT INDUSTRY AND CLIMATE CHANGE

The industry itself.....

The cement industry employs about 850,000 workers in facilities in 150 countries; it produces about 1.5 billion tonnes of cement a year. It has an estimated annual turnover of $87 billion and has grown by nearly 4% a year over the past decade

.....its impact on the Earth's climate.....

The industry emits nearly 900 kg of CO2 for every 1000 kg of cement produced. The manufacture of cement is an energy-intensive and greenhouse gas emissions intensive process that requires large amounts of thermal energy to heat the raw materials necessary to produce cement. You can see that from all the steps required to produce cement!!!

STEEL: HOW IS STEEL MANUFACTURED?

First, the iron, which is the main raw material has to be extracted from the earth in the form of iron ore by mining procedures.

The next step is to take out the iron from the iron ore. The more advanced way to smelt iron is in a blast furnace (see diagram below). A blast furnace is charged with iron ore, charcoal or coke (coke is charcoal made from coal) and limestone (CaCO3¬).

Iron Ore

Sources: science.howstuffworks.com

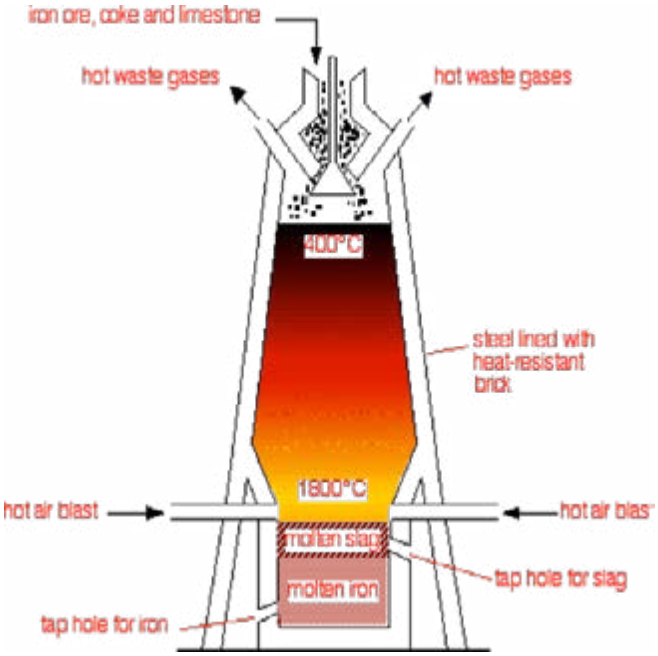


Diagram: Blast Furnace source: chemguide.co.uk

Huge quantities of air blast in at the bottom of the furnace, and the calcium in the limestone combines with the silicates to form slag. Liquid iron collects at the bottom of the blast furnace, underneath a layer of slag. The blacksmith periodically lets the liquid iron flow out and cool.

The temperature at the core of the blast furnace reaches nearly 3,000 degrees F (about 1,600 degrees C).

The final and last step is manufacturing the steel itself from pig iron. Steel is iron that has most of the impurities removed.

Impurities like silica, phosphorous and sulphur weaken steel tremendously, so they must be eliminated. These impurities, including carbon, are oxidized and float out of the iron into the slag. As seen in the diagram below, much gas is spent and released in to the atmosphere, greatly contributing to Climate change.

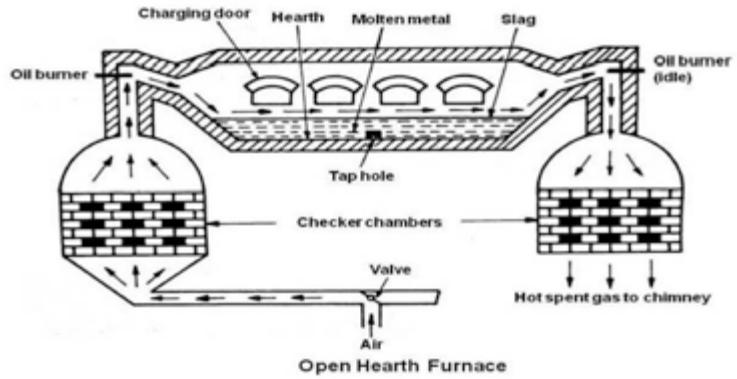


Diagram: open hearth furnace source:practicalmaintenance.net

Environmental problems in mining and transporting the raw materials for the production of steel.

THINK ABOUT:

- Loss of landscape due to mining, processing and transporting the iron ore, coke and limestone.
- Noise and air pollution (greenhouse effect, acid rain) involved in these operations.
- Extracting iron from the ore

THINK ABOUT:

- Loss of landscape due to the size of the chemical plant needed.
- Noise.
- Atmospheric pollution from the various stages of extraction. For example: carbon dioxide (greenhouse effect); carbon monoxide (poisonous); sulphur dioxide from the sulphur content of the ores (poisonous, acid rain).
- Disposal of slag, some of which is just dumped.
- Transport of the finished iron.
- Recycling

THINK ABOUT:

- Saving of raw materials and energy by not having to first extract the iron from the ore.
- Avoiding the pollution problems in the extraction of iron from the ore.
- Not having to find space to dump the unwanted iron if it wasn't recycled.

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2. Road construction

The primary material used in road construction in Seychelles is asphalt, also known as bitumen. It is used as a binding substance to hold aggregate particles together. The end product is asphalt concrete, which is used then to surface roads.

Asphalt/bitumen can be **separated from** the other components in **crude oil** (such as naphtha, gasoline and diesel) by the process of **fractional distillation**, usually under vacuum conditions. Asphalt/bitumen is typically stored and transported at temperatures around **150°C (300°F)**. Sometimes diesel oil or kerosene is mixed in before shipping to retain liquidity.

There are four steps in the extraction of bitumen. These are

1. Conditioning
2. Separation
3. Secondary separation
4. Froth treatment

1. CONDITIONING

Naturally, bitumen is found mixed within a substance known as oil sand. Conditioning is the first step in the extraction of bitumen from oil sand. In this step, lumps of oil sand is broken up and mixed with water, a mixture known as slurry. The oil sand is then crushed and mixed with warm water.

Conditioning starts the separation of the bitumen from the sand by breaking the bonds that hold the bitumen, water and sand together.

2. SEPARATION

The blended slurry is fed into a **Primary Separation** Vessel (PSV) where it is allowed to settle into three layers. Additional hot water is added as the slurry arrives which allows separation to take place rapidly. Impure bitumen froth floats on top, sand sinks to the bottom and a combination of bitumen, sand, clay and water sits in the middle (known as middlings).

3. SECONDARY SEPARATION

The **middlings** is a suspended mixture of clay, sand, water and some bitumen. Secondary separation involves injecting air into the middlings in flotation tanks. This added air encourages the creation of additional bitumen froth. Steam is used to heat the froth (to approximately 80°C) and remove excess air bubbles, in a vessel called a **de-aerator.**

4. FROTH TREATMENT

Bitumen froth is far from pure, it contains, on average, about 30% water and 10 % solids (mainly clays) by weight. At the froth treatment plant the bitumen is diluted with naphtha, to make it flow easily. Then, it is centrifuge, which works like a spin cycle on a washing machine and spins the remaining solids and water outward.

The clean diluted bitumen product is now dry (less than 5% water) and with only small amount of solids (0.5% mineral). This completes the extraction process.

This hot water extraction process recovers over 91% of the bitumen contained in the oil sand feed. The bitumen is now ready to be upgraded into synthetic crude oil.

Water is a major use in the extraction of bitumen, especially in its vapour form. Water vapour is the most important greenhouse gas. It acts as a positive feedback for the increase in temperature caused by carbon dioxide. What happens is that as more water vapour is added to the atmosphere, more heat is trapped and the temperature rises further.

SECTION 4:

MITIGATING AND ADAPTING TO CLIMATE CHANGE.

Mitigation refers to policies or actions that reduce the size of climate change, for example, any action that reduces greenhouse gas concentrations. In other words, mitigation can be defined as reducing the physical causes of an environmental problem.

Adaptation however, is any response that reduces the impact of climate change. It may also be described as any action or steps taken to make the impacts of climate change less problematic.

The building and development industries are under tight scrutiny about their overall contribution to overall greenhouse gas emissions.

POSSIBILITIES FOR MITIGATION: OPPORTUNITIES TO REDUCE EMISSIONS

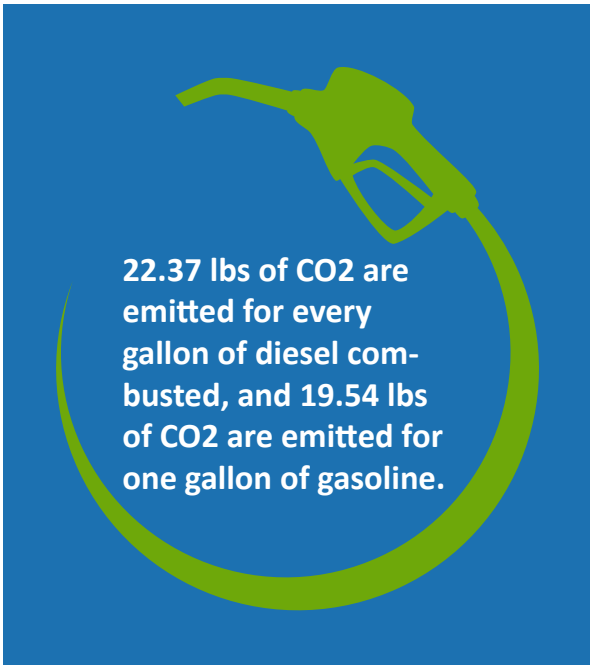
Construction contractors may have control over many of the activities associated with GHG emissions at a construction site, such as how efficiently they use fuel and electricity. This section examines options for reducing greenhouse gas emissions associated with construction activities, focusing on the activities that construction companies control or influence. The options presented in this section are based on currently available technologies and techniques.

1. REDUCING FUEL USE

Approximately three-quarters of the GHG emissions from the construction sector result from diesel, gasoline, and natural gas combustion. The GHG reduction options focus on reducing the emissions from fuel combustion, primarily by improving fuel efficiency. Better fuel efficiency results in less fuel consumed to complete the same job often, the steps taken to improve fuel efficiency also result in other benefits, including increased equipment life and reduced emissions of other air pollutants such as particulate matter. As contractors implement techniques to reduce their fuel costs, they will simultaneously reduce their GHG emissions.

2. REDUCED IDLING

Unnecessary idling occurs when trucks wait for extended periods of time to load or unload, or when equipment that is not being used is left on, such as to maintain heating or cooling for driver comfort. Reduced idling reduces fuel consumption and the associated costs and GHG emissions.



3. EQUIPMENT MAINTENANCE

Proper maintenance often results in fuel savings, although the magnitude of savings varies by equipment type and condition. Maintenance may include systematic equipment inspection, detection of potential failure, and prompt correction.

Did you know??? A recent study of forklift maintenance estimated that 50% of forklifts were not properly maintained, each of which could be wasting more than 400 gallons of propane annually. Propane emits about 12.7 lbs of CO2 per gallon, resulting in more than 2.3 tons of CO2 emitted by each improperly maintained forklift each year.

4. REUSING/RECYCLING BUILDING MATERIALS

GHGs are released during the manufacturing and transportation of construction materials. When materials are reused or recycled, the associated emissions that would have occurred during virgin material manufacturing are avoided.

Recycling is the process of reprocessing or reforming used materials into new products, while reuse is the process of using a recovered, previously used product instead of a new product.

FOCUS: CRUSHED GLASS IN THE CONSTRUCTION OF ROADS

Thousands of tons of glass bottles and jars enter landfills each day. Recycling this glass is a good way to help reduce the waste, lower construction costs and help with the environment. Waste glass that is crushed can be used as a portion of fine aggregate in asphalt paving mixes.

Asphalt containing glass cullet as an aggregate is called 'glassphalt'. Mixing crushed glass with asphalt produces a long wearing road surface. The crushed glass adds strength to the asphalt mix and reduces the cost of road construction

Other uses of glass in construction.

Glass bottles for fence building

Image source: http://www.chasingmirages.com/

Glass for window decorations in popular churches

Image source: http://upload.wikimedia.org/

Glass for interior and exterior design

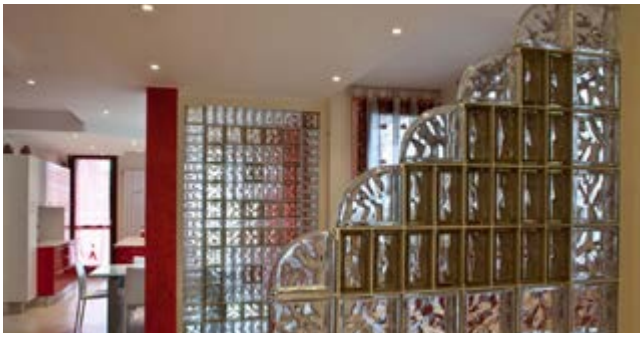


Image source: http://inhis.com/

Image source: http://artistryinglasstucson.files.wordpress.com/

Image source: http://4.bp.blogspot.com/

5. MATERIALS SELECTION, PROCUREMENT AND SHIPMENT METHODS

The selection of materials with lower environmental impact provides a range of opportunities to reduce GHG emissions, although emissions reductions vary considerably depending on the material. Delivery of materials to a construction site also results in GHG emissions. Reducing delivery-vehicle trips to the construction site results in lower fuel consumption, which will contribute to reduced GHG emissions.

For large projects or group of projects in close proximity, creating a consolidated location for materials delivery may reduce transport emissions by allowing contractors to request materials and quantities closer to the time of use.

For shipments over a significant distance, switching transportation methods may also enable emissions reductions. Buying locally produced lumber and other materials can reduce the emissions impacts of transporting materials. The magnitude of these savings varies widely by the construction site location and the source of the materials.

ADAPTATION

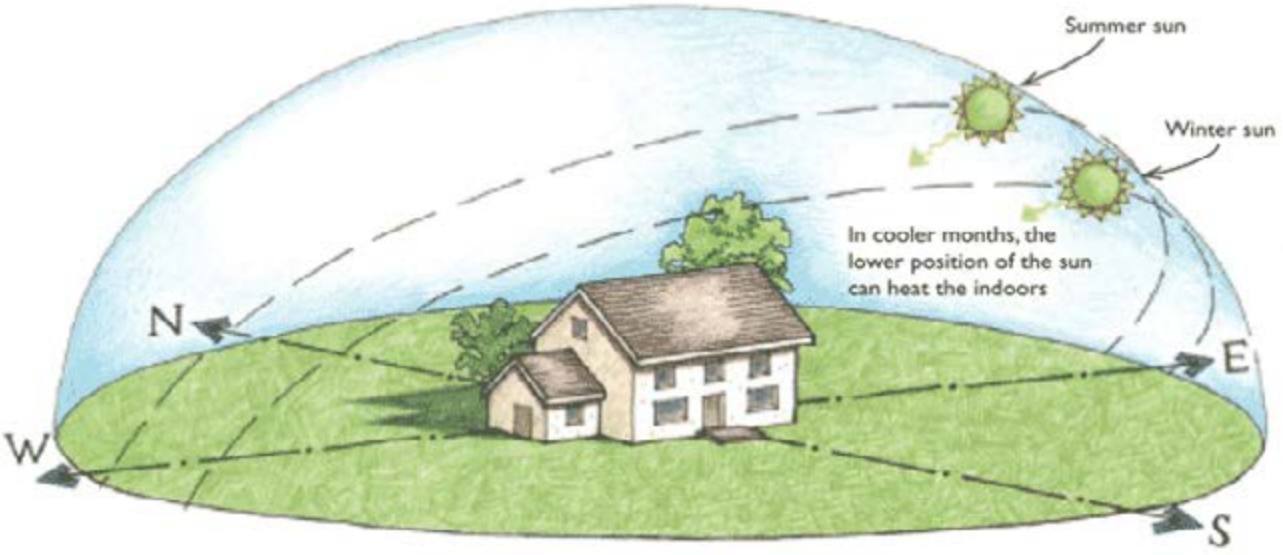
Adaptations can range from traditional structures built to cope with increased flooding, to innovative engineering techniques aiming to withstand hurricanes.

Image source: S4S photo library

Image source: http://images.cdn.fotopedia.com/

Traditional building designs and techniques will not cut it in the future and the industry needs to wake up to its dual role in helping people cope with the unavoidable effects of **climate change whilst making more efficient buildings to aid efforts** to prevent things getting worse. There are several aspects to an efficient building:

1. ORIENTATION



Sun position for Northern Hemisphere. It will be the opposite for Southern Hemisphere.

Buildings should be orientated in the proper direction so as to minimise the use of energy. In Seychelles, buildings should limit the use of air conditioning and artificial lightings.

Therefore, since the sun rises in the east and sets in the west, this implies that there will be heat accumulation on the east face in the morning and on the west face during the afternoon. For this reason, the house should be designed rectangular rather than square, with the shorter faces on the east and west.

Also, due to inclination of the earth, the sun will tend to incline a bit to the north during winter in the southern hemisphere (to the south in northern hemisphere). This is known as the northern exposure, which will cause the northern face to be the hottest face in the Seychelles. So, fewer openings should be on that face, with maximum possible shade from trees. On the southern face, on the contrary, the openings should be large so as to welcome in maximum natural light, without excessive heating.

A FEW TIPS…..

- Morning sun is dominant in east-facing rooms. Locating the dining room or breakfast nook and the kitchen on the east wall makes the most of light potential early in the day. It's also a good place for a dense floor that can soak up some solar heat for the day. Bedrooms with east-facing windows will be great for early risers.
- Sunlight is strongest on the north wall. This is the right quadrant for the living room and other spaces that will be used throughout the day.
- Early evening light from the west is at a low angle. Because the sun is so low in the sky, west-facing windows get direct sunlight blazing through them. This makes west-facing rooms a bad choice for TV rooms because strong light makes screens harder to see. A west bedroom is good for people who like to sleep in because the room is very dark in the morning.
- South rooms have the least natural light. They also have the greatest potential for heat loss through windows. This is a good place for bathrooms, utility rooms, entries, and other rooms where natural light isn't as important.

2. MAXIMISING THE USE OF DAYLIGHT

Light can be allowed inside a house as shown in the diagram, whereby a reflecting pane will reflect the light, even at angles, to the ceiling and back to the house. The reflecting plate is best if made of a heat absorbing material, so as to reflect only light, and block undesired heat.

3. INSULATION

A major concern so as to reduce both the direct effect and indirect effect of households on climate change is house insulation. The direct effect is that through heat loss form houses, the immediate environment of the house will be hotter, thus heating up the atmosphere directly. The indirect effect is that through energy loss by heating or cooling, there will be more use of fuel, thus more carbon emission to the atmosphere.

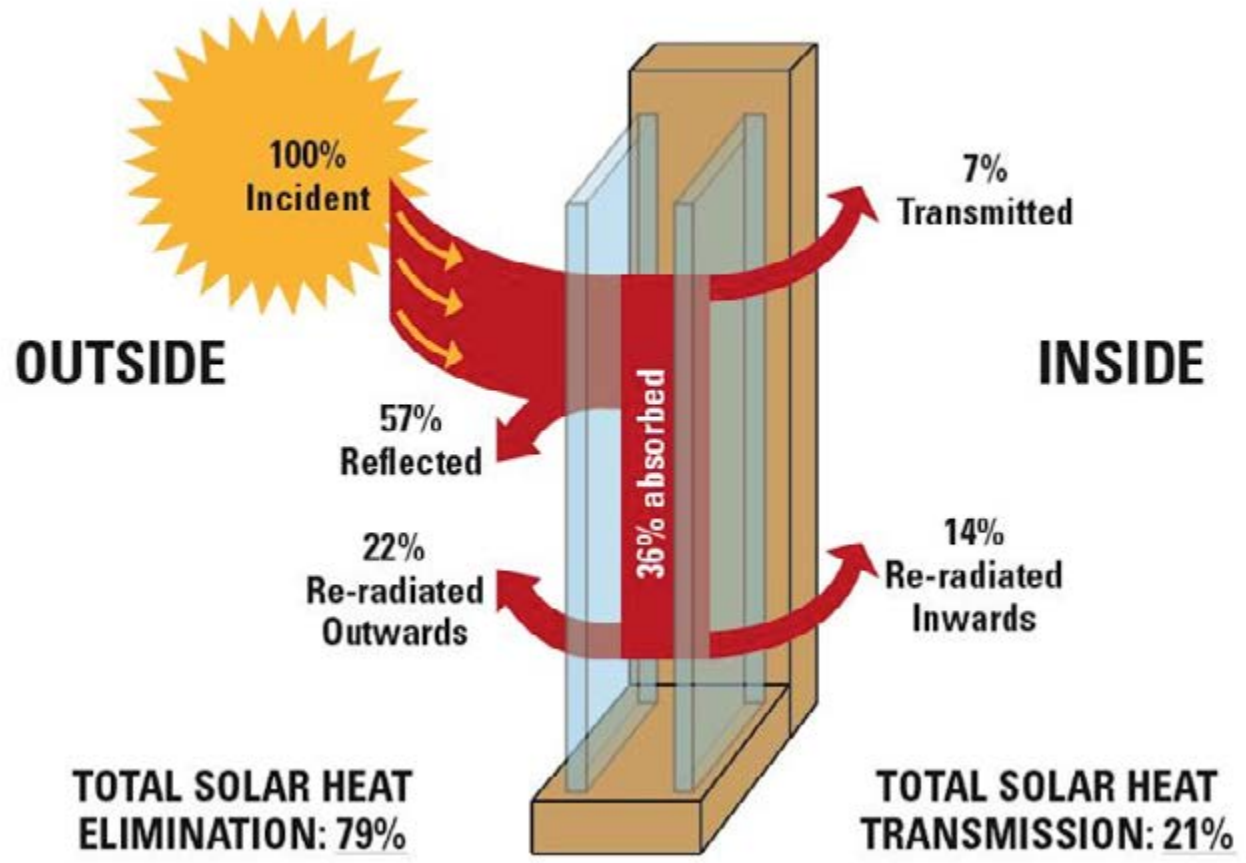
In the Seychelles, the major problem is the roofs which are mostly made of steel sheets. Steel is a very good conductor of heat. Thus, heat can pass in and out almost freely. During the day, the sun will heat up the steel sheet, causing excess heat accumulation. At night, heat will be lost by the same way, this time from the inside.

The false ceiling will of course reduce the effect, but not as much as required. It would be optimised if above the false ceiling, the roof was to be insulated by wool as it is in snowing countries, to try to preserve the house from losing heat, and in our case to preserve the house from gaining heat. Wool is a very good insulating material as naturally, it has air particles trapped in between the threads.

4. DOUBLE GLAZED WINDOWS

It is well known that a lot of energy is lost through windows. In Hot Climates, the energy loss comes in cooling down the room. But a lot of heat passes through and the coldness is lost through windows since window panes are very thin, and thus, not so good insulators.

This problem must be tackled in the construction process itself. The effect of loss of coldness can be reduced considerably by double glazing. This is a structure where two window panes are placed in the same window space with a small air gap held airtight between them. As mentioned earlier, still air is among the best insulators known to man, and is very accessible at low cost projects.



For warm climates like the Seychelles, it would be best to use a soft low-e coating that is typically a spattered layer of silver on the already-hardened pane of glass. This layer is less durable compared to the hard coat of indium tin oxide, but delivers less light transmittance, thus rejecting more radiant energy from the sun.

This will eventually lead to the gain of unwanted heat. For even better results, this layer should be applied to the outer most surface of the window, but due to the delicate nature of the soft low-e coatings, can be applied to the surface just inside the air-space of the window (in double glazing).

5. ROOF VENTS

During hot seasons, a lot of heat is accumulated in the attic, especially if the roof is made of steel. This heat radiates down to the house, eventually creating the need of cooling the house. This phenomenon can be greatly reduced by ventilating the attic.

Roof vents are inexpensive and easy to install. They should be located at each end of the roof and every 12' between ends. Installing roof vents will not make the house cooler in winter; they will help remove moisture from the attic.

6. ECO-LIGHTING IN THE HOUSE

A very simple, but un-thought method to reduce cost of lighting in houses would be the use of mirrors in specific orientations with adequate openings inside the house. Big openings will ensure a good lighting during the day. But for places where it is not practical to put domes, such-as in toilets or bedrooms, mirrors are a good solution. Mirrors, during the day can direct the light of the sun in places inaccessible to natural light. At night time also, if the mirrors are placed near artificial lighting sources and directed properly, a lot of energy can be saved instead of placing an additional light, say for studying.

Ridge Vent: For even more effective attic ventilation, a continuous ventilation system, can be installed along the ridge.

SECTION 5:

SUSTAINABLE CONSTRUCTION

The concept of sustainable building incorporates and integrates a variety of strategies during the design, construction and operation of building projects. The use of green building materials and products represents one important strategy in the design of a building.

Building and construction activities worldwide consume 3 billion tons of raw materials each year or 40 percent of total global use. Using green building materials and products promotes conservation of dwindling non-renewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transportation, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.

Source: greenhabbing101.com

WHAT IS A GREEN BUILDING?

Green building materials are composed of renewable, rather than non-renewable resources. Green materials are environmentally responsible because impacts are considered over the life of the product. Depending upon project-specific goals, an assessment of green materials may involve an evaluation of one or more of the criteria listed below.

Green building is not only a wise choice for our future; it is also a necessary choice. The construction industry must adopt eco-friendly practices and materials that reduce its impacts, before we reach a point of irreversible damage to our life supporting systems.

The industry needs to take its own initiative and find alternative ways to build, using green, renewable energy resources, and adopt non-polluting practises and materials that reduce, recycle and reuse, before it is too late.

FOCUS:

COB BUILDING

Making buildings with dirt is an idea that's been around almost as long as man has been on earth. We've all done it-as kids most of us built little things with mud. Cob building, a tradition from Cumbria and Southwest England, is like that, but on a bigger scale. It was used for centuries, dying out in the 1800s until interest in sustainable housing sparked a revival.

THE TRADITIONAL BUILDING TECHNIQUE

The traditional material for English cob was **soil (clay-based) mixed with water and straw,** sometimes with crushed flint or sand added. People shovelled or stamped the mixture together, after which a cob fork was used to ladle it onto a stone foundation, before workmen on the walls trod it into place.

The builders would either leave openings for windows and doors, adding stone lintels as they went, or carve them out later. It was a community effort, with men working one day a week to build a house in a season.

MODERN CONSTRUCTION

Unsurprisingly, perhaps, modern cob techniques remain much the same. The biggest development has been Oregon cob, where people mix the material into mud loaves, then add them individually to the wall before treading them in. This method means houses can have walls that are stronger and thinner (generally 300-500mm thick on load bearing walls, as little as 100mm on others).

MATERIALS

You can make your own cob, even if you don't live in an area with heavy clay content in the soil. Just mix soil, clay, sand and straw to a consistency like dough, and start your wall.

CONSTRUCTION

You're going to find the process very labour-intensive. The good part is that it's **very environmentally-friendly** - all done by hand.

Image source: http://4.bp.blogspot.com

Image source: http://tinyhouseblog.com/

Image source: http://gatherandgrowdotorg.files.wordpress.com/

Image source: http://www.c2cn.eu/

THE CASE OF GREEN ROOFS.

Not only are these quite therapeutic, but with the incidence of increased rainfall amounts and a rise in the number of flooding events, green roofs are ideal for adaptation to climate change. Green roofs not only provide a sink for all the carbon dioxide released by burning fossil fuels, it also acts a sponge to suck up all the extra storm water from off rooftops that may contribute to flooding events.

A **green roof** is a roof of a building that is partially or completely covered with vegetation. Apart from absorbing rainwater, green roofs create habitat for wildlife, and also help reduce air temperatures, mitigating global warming.

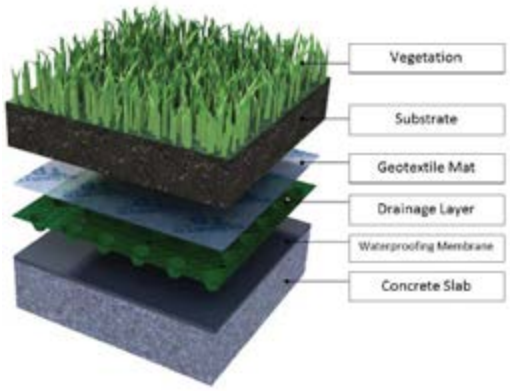
In the case of Seychelles, which is an equatorial country, the green roof buildings must be adjusted and adapted to its environment. Hot countries like the Seychelles are prone to mosquito and other insects' proliferation. These insects are the vectors of many diseases, which may turn into a national epidemic. To prevent this, we cannot use any green plant. The green plants to be placed should be specifically adapted so as not to inhabit harmful insects. More research must be done on these species of plant, or else, there would be the need of using chemicals to eradicate the harmful bugs, and that would not be good for the environment.

Image source: http://livelitelund.files.wordpress.com/

Image source: http://tinyhouseblog.com/

HOW TO BUILD A GREEN ROOF!!!

1. Start with a waterproof membrane.
2. Add a root barrier like cellular glass.
3. Put in a drainage layer made from gravel and pumice.
4. Add a filter fabric preferably made from polyester or polypropylene.
5. Put in a growing medium. You can use local soil.
6. Install drip irrigation, or leave it up to Mother Nature.
7. Add plants.



Source: solarchoice.uk.com science.howstufworks.com
Read more: http://www.ehow.com/how_4798100_build-green-roof.html#ixzz2ncrZ3Igl

WATER EFFICIENCY IN THE CONSTRUCTION SECTOR

Tremendous energy resources are used to procure, pump, treat, transport, and store potable water. Energy is also used to treat used water in the form of sewage. Potentially toxic chemicals are essential to this process. Using such potable water to irrigate lawns or flush human waste away is a waste of this energy intensive resource.

The necessity for water efficient practices will become far more apparent as water and energy prices continue to fluctuate, leading to increased attention and focus on the mitigation of climate-related impacts and as water scarcity issues continue to plague certain parts of the globe.

The protection and conservation of water must be considered throughout the life of the building. Facility owners and developers must seek to:

- Use water efficiently through high efficiency fixtures, elimination of leaks, water conserving cooling towers, and other actions;
- Recover non-sewage and graywater for on-site use (such as toilet flushing and landscape irrigation)
- Establish waste treatment and recycling centers on the construction site;
- Practice rainwater harvesting

Rainwater harvesting is the accumulation and deposition of rainwater for reuse. Rainwater harvesting provides an independent water supply during regional water restrictions and in developed countries is often used to supplement the main supply. It provides water when there is a drought. Seychelles has an annual rainfall of 350cm, providing ample opportunity for individual households to harvest rainwater.

Rainwater harvesting systems can be installed with minimal skills. The system could be as basic and simple as an open barrel well placed where the rainwater drains off a roof. It's a good idea to keep your barrel covered when it's full to stop mosquitoes breeding in it.

If you have gutters along your roof and want to go a little more high-tech, you can connect your roof to a downpipe leading straight into a covered tank with a tap installed somewhere down near the bottom. More high-tech options include pumping rainwater up to a tank in the attic or somewhere else high enough to provide good water pressure. If you are still building your house, you could incorporate an underground

Image source: http://www.storm-saver.com/

Image source: S4S Photo Library

Image source: S4S Photo Library

CLIMATE CHANGE, THE CONSTRUCTION INDUSTRY AND THE NEED FOR REFORESTATION

For the pending disaster concerning the use of timber in construction, there is not much we can do. But the government of each and every country could certainly implement laws, whereby every big stakeholders of the timber industry should plant back what they remove from nature. If two small plants were planted for every plant removed, it is very probable that at least one of them would reach adulthood into a big and healthy tree. This would without any doubt help our environment.

LESSON ACTIVITIES

SECTION 1:
WHAT IS CLIMATE CHANGE.

ACTIVITY 1

List some of the activities that humans undertake that may contribute to climate change.

a)

b)

c)

d)

e)

f)

ACTIVITY 2

Ask students to design a poster to showcase some of the construction-related activities they think are the number one contributors to climate change.

ACTIVITY 3

Ask students to design a poster to showcase some of the construction-related activities they think are the number one contributors to climate change.a)

List some of the behavioural changes humans may engage in to reduce their carbon footprint.

a)

b)

c)

d)

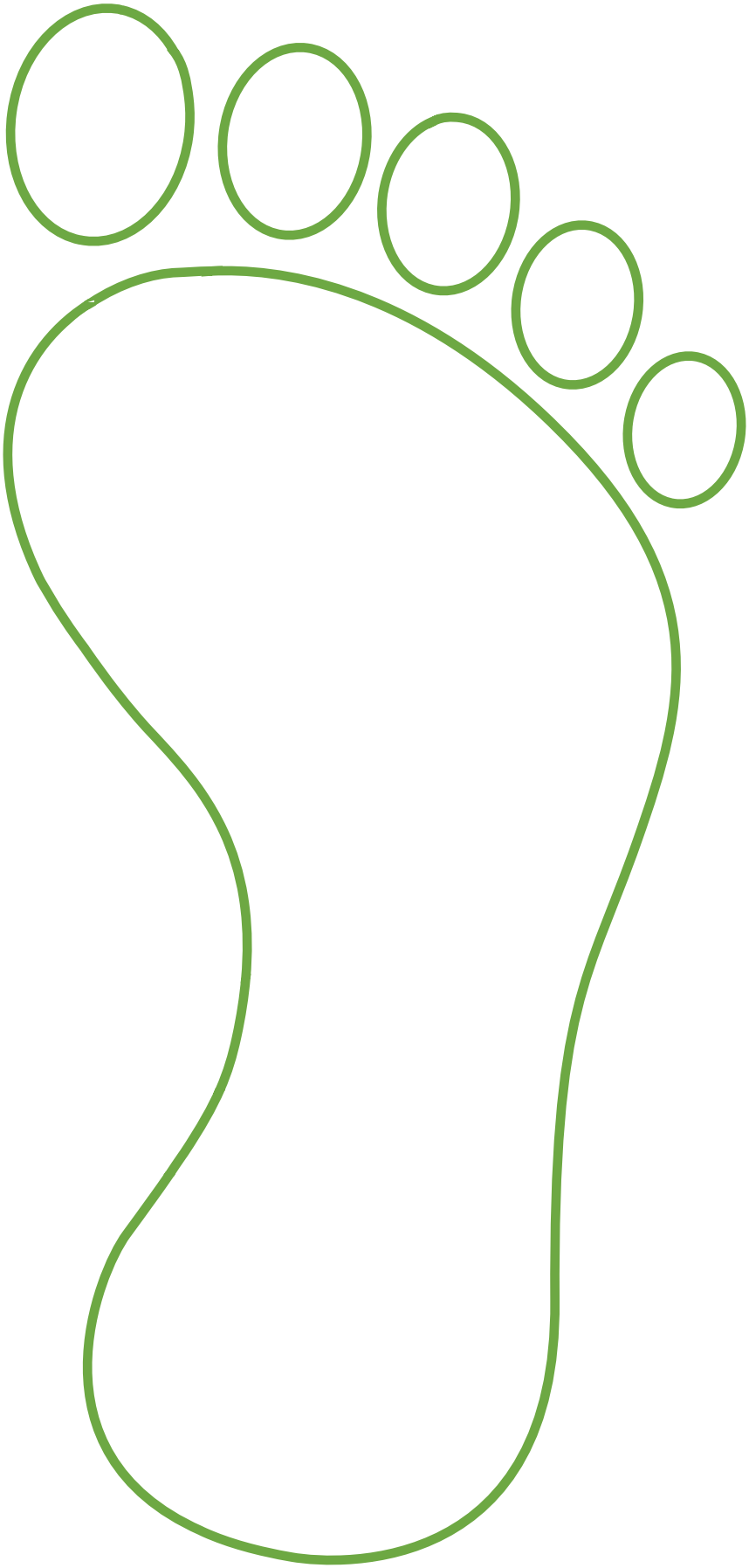
e)

f)

g)

ACTIVITY 4

Reflect closely on, and scrutinize your everyday activities. Which of these activities do you think are more climate unfriendly? Draw or write them down on the footprint provided. Brainstorm on possible ways of reducing your footprint.



ACTIVITY 5

In groups of 4, design and implement a small advert to educate your peers more on one chosen sustainable practice. For example, if you chose 'ride a bicycle to school' as an example, create an advert/promotion for the practice, putting emphasise on the activity's potential as a sustainable practice. The advert/promotion may be for TV/radio or newspaper.

Present to your peers. Ideas:

- ✔ Ride a bicycle to school
- ✔ Ride the bus instead of taking your car
- ✔ Turn off electrical appliances when not in use
- ✔ Recycling and reusing
- ✔ Carry your own water bottle
- ✔ Buy locally produced goods

ACTIVITY 6 (PRINT)

Below is a climate-form that can be used to assess how climate-friendly your school is. Print off the form, and give to the students to complete as an activity.

1. Find 5 ways your school is contributing to climate change.
   (Remember that 3 of the biggest emitters include transportation, solid waste, and energy)

i.

ii.

iii.

iv.

v.

2. List the ways in which your school is helping to reduce the amount of carbon emitted from its premises.

1.

2.

3.

4.

5.

6.

3. Thinking of the same pollution issues as above, describe what could be done better.

4. Design a poster to educate others on the school premises on a more sustainable way of doing things.

ACTIVITY 7 (PRINT)

Footprint calculator: Assign points to each of the following activities. Be honest!!
Add up your score to see how climate friendly you are as an individual.

SCORING:

0 points- *Never do this*

1 point- *Sometimes do this*

3 points- *Usually do this*

5 points - *Always do this*

I recycle _
I take short showers _
I turn off lights/appliances when not in use_
I have and encourage the use of florescent light bulbs_
I have fruit trees/vegetable patches at home that I use_
I buy locally produced foods/items_
I carry my own water bottle_
I carry reusable lunchboxes_

SCORE:

0-10 you can do a lot more to help our planet

11-22 you've taken a few steps but you have some ways to go

23-35 you've got the idea but need to do just a little more

35-40 you are excellent, and an inspiration to others!!

ACTIVITY 8

Some people are still very sceptical about climate change. Research some of their most commonly used arguments and list them below.

i.

ii.

iii.

iv.

v.

ACTIVITY 9

List some of the damages that may occur to a building following a flood event.

a)

b)

c)

d)

e)

f)

ACTIVITY 10

Pretend that you are a supervisor on a construction site and your project is being greatly delayed due to the effects of climate change (unreliable water shortage, frequent floods, uncharacteristically strong winds and heavy rain etc). Think about all the different aspects of construction that climate change can have an impact on. Write a small memo to your boss, detailing the risks affecting the project, and describing what you think needs to be done.

ACTIVITY 11

Visit a large construction site and go around to see how water is being used on the site. List those usages. Think about the possible ways in which these usages are wasting water. Design a Guideline for Best Practices for the construction site.

ACTIVITY 12

Ask students to Refer to the instructions on page 26 on how to build a green roof. Supervise the Building of a small model for the end of year exhibition at the school

ACTIVITY 13

Visit a construction site (make sure you have permission). Find out

a. How much water is used in a month? What is the water used for? What percentage of their production costs does water usage take up? Draw a pie chart to illustrate your findings.

b. What measures have they taken to ensure they have water all year round? Was any of the water recyled/ reused? Were there costs involved? Are there ways that water use could be minimised in the different businesses? Compare results with other groups.

c. Present your findings as an exhibition on World Water Day (March 22nd) or one of the school's Open Days.

ACTIVITY 14

Adaptation to climate change involves substituting some of the current materials being used in construction for greener alternatives. Invite a guest lecturer from SBS to talk about the implications of using alternative construction materials such as glass, shredded tyres, mud/clay mixed with cement. Are alternative building materials considered sub-standard? What are the difficulties associated with giving permission to build from alternatives and what could be done to overcome the issue.

ACTIVITY 15

Invite a guest speaker either from DRDM or RED CROSS to present an 'eye opening' power point on the negative impacts that climate change can have on buildings. Give the guest speakers 15-20 minutes to deliver their presentation. The rest of time can be used as question/discussion time, so get students to prepare questions, views and comments before hand.

***Note:** Ask the guest speaker to keep the presentation interesting by incorporating photos, case studies/examples etc, and keeping reading to a minimum.*

ACTIVITY 16

DESIGN COMPETITION

Divide the classroom into 5 groups.

1. Group 1: Design a small luxury hotel in the hills of Bel Ombre
2. Group 2: Design a mall on the outskirts of Victoria.
3. Group 3: Design a unit of 4 flats at Ile Soleil.
4. Group 4: Design a brand new luxury home at Bougainville
5. Group 5: Design an office building in the centre of Victoria

Instructions: be creative, there are no limits. Make use of existing technologies and invent your own and envision the location of the 'project'. Make the project as climate change-resilient and eco-friendly as you possibly can. Present your project to the class, explaining how and why your design is climate change-resilient and eco-friendly.

Teacher's note: when the groups have been formed, give students about a week to put together their ideas on what they want to include. They should be ready to draw and present, on the day you decide to have the activity. When judging which group wins the competition for the most climate-resilient/eco-friendly project, make sure the following are present in their design. You could award a score for each point to work out a total.

- Recycled materials
- Renewable energy…was solar/wind energy incorporated?
- Protection of biodiversity where available/possible
- Minimal disruption to the environment
- Use of alternative building materials other than concrete
- Attention to water efficiency…was rain water harvesting considered?
- Etc

NOTES

Sustainability for Seychelles (S4S) is a non-governmental environmnetal organisation (ENGO) based in the Seychelles, with the mission to promote sustainable. 'green' living in Seychelles, in collaboration with citizens, the Government, other NGOs and the private sector.

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