

UN HABITAT

FOR A BETTER URBAN FUTURE

Annexure C – Course syllabus

Module 7: Climate Change and Shelter and Housing

TABLE OF CONTENTS

1. **Course unit outline**
2. **Course programme and contents**
3. **Course materials**
4. **Additional study material**
 - 4.1 Additional reference material
 - 4.2 Supplementary sheets
 - 4.3 What to include in a Baseline Survey
 - 4.4 How to formulate a Questionnaire
 - 4.5 Ecological Footprint Questionnaire
5. **Overview of assignments**

1. COURSE UNIT OUTLINE

Unit leader

Name

Supporting lecturers

Names

Unit status

Number of credits: xx
Timing: Semester xx
Time of allocation/distribution: 1 week intensive

Pre-requisites to join the course unit

Completion of Course unit / modules 1 and 2

Brief description

This course unit introduces issues surrounding climate change, shelter and housing. It focuses on principles, methods, and design strategies for developing sustainable buildings. Specifically, the course introduces key problems that are prevalent in vulnerable environments, especially in rapidly growing cities of the South, that need critical attention in order for shelter to progress towards the goal of sustainability. Students will analyse and understand the consequences of climate change to the built environment – especially shelter - and will be provided with a range of corresponding tools for creating solutions for mitigation and adaptation strategies.

Learning outcome

At the end of the module students should be able to:

- Understand conditions in the built environment relating to climate, location and availability of building resources.
- Appreciate the impact of climate, weather and in particular extreme weather events on shelter needs.
- Understand economic, social and cultural factors that influence the provision of solutions.
- Appreciate the impact of building design and urban form on energy consumption and greenhouse gas emissions.
- Understand to factors that influence calculations of life cycle impacts of building choices.

- Understand options for energy efficient and climate resilient housing (particularly low cost housing).
- Understand the relationship between shelter, urban policy and legislation (including codes).
- Be aware of tools at the disposal of urban professionals to address shelter/housing in the context of climate change.

Key content

A DEFINITION AND CONTECT OF HOUSING AND CLIMATE CHANGE

B SHELTER AND CLIMATE CHANGE MITIGATION STRATEGIES

1. Planning,
2. Housing Design,
3. Equipment,
4. Renewable Energy Substitutes
5. Carbon offset through photosynthesis and carbon sinks
6. Behaviour

C SHELTER AND CLIMATE CHANGE ADAPTATION STRATEGIES

7. Heat – Thermal Comfort / Passive design / natural ventilation
8. Cold – Insulation / thermal storage / passive heating
9. Storms – Robust construction / settlement planning
10. Rain – Protection / storage /
11. Drought - Water efficient and drought resistant buildings and lifestyles
12. Flooding – Reducing exposure / increasing resilience / response planning

Modes of delivery

Lectures (2-6 Contact Hours) – in 2 parts: mitigation and adaptation

Student-led learning

- Seminars, Assessments of Climate Housing Strategies, Shelter Profiles, Design principles, Green buildings standards and codes, low cost housing design, slum upgrading. etc.
- Workshop on Design, Simulations, Mapping and Testing of Low Cost Housing.
- Fieldwork or Group Project: Neighbourhood Design (Ho Chi Min City)

Case studies

- Housing programmes from different countries / regions / cities that take (or do not take) climate change into consideration.
- Shelter strategies
- Slum upgrading strategies
- Post disaster reconstruction– disaster preparedness

Students responsibilities

- Active participation in lectures, group discussion and group projects
- Study all required materials
- Complete various written reports and assignments
- Complete final examination

Key texts

1. Hopkins, Rob (2011). *The Transition Companion: Making Your Community More Resilient in Uncertain Times*, Transition Books, Totness.
2. Konya, A. and M. Vandenberg (2011). *Design Primer for Hot Climates*, Archimedia Press Limited, Reading.
3. Newman, P. and I. Jennings (2008). *Cities as Sustainable Ecosystems: Principles and Practices*, Island Press, Washington.
4. Newman, P., T. Beatley and H. Boyer (2008). *Resilient Cities: Responding to Peak Oil and Climate Change*, Island Press Washington.
5. Nicol, F., M. Humphreys and S. Roaf (2012). *Adaptive Thermal Comfort: Principals and Practice*, Earthscan. London.
6. Roaf, S., A.Horsley and R.Gupta (2004). *Closing the Loop: Benchmarks for Sustainable Buildings*, RIBA Publications, London.
7. Roaf, S., D. Crichton and F. Nicol (2009). *Adapting Buildings and Cities for Climate Change*, Architectural Press. 2nd Edition. In Press.
8. Roaf, S., M.Fuentes and S. Thomas (2012). *Ecohouse: A Design Guide*, 4th Edition, Architectural Press, Oxford.
9. Watson, D., and M. Adams (2010). *Design for Flooding: Architecture, Landscape, and Urban Design for Resilience to Climate Change*, John Wiley and Son.
10. Wolfe, S. and D. Stangel (2013). *How to Future Proof Your Home: A Guide to Building with Energy Intelligence in Cold Climates*, available from www.futureproofmybuilding.com

Student assessment

Mode	Weight in total Mark (%)
Group assignment 1	10%
Group assignment 2	20%
Group assignment 3	35%
Final examination	35%
Total	100%

3. COURSE MATERIALS PROVIDED

2 Lectures of 2 hours each (ppt copies)

3+ Programmed exercises (included in lecture notes)

Case Studies (PDF Versions)

- Large Case study 1 Vietnam with Design handbook
- Large Case study 2 India
- Small Case Study 3 Nicaragua with Booklet
- Small Case study 4 UN-ISDR Building Disaster Resilient Communities
<http://lauratest.drupalgardens.com/en/media/1416> (provided as weblink only)
- Small Case study 5 Brick Constructions St Louis, Senegal
- Collection of 19 further externally provided case studies with internet links

Reading list (PDF version)

Syllabus (PDF version)

Team of Authors

Kosta Mathey (PI)	mathey@ina-fu.org
Susan Roaf	S.Roaf@hw.ac.uk
Christoph Hesse	mail@christophesse.eu

Glossary of Energy- and Climate Related Terms

(Sources: BBC Science and Environment, Sustainable Energy Coalition, Green Ideas, US Department of Energy)

Active Cooling

The use of mechanical heat pipes or pumps to transport heat by circulating heat transfer fluids.

Adaptation

Action that helps cope with the effects of climate change - for example construction of barriers to protect against rising sea levels, or conversion to crops capable of surviving high temperatures and drought.

Adiabatic

Without loss or gain of heat to a system. An adiabatic change is a change in volume and pressure of a parcel of gas without an exchange of heat between the parcel and its surroundings. In reference to a steam turbine, the adiabatic efficiency is the ratio of the work done per pound of steam, to the heat energy released and theoretically capable of transformation into mechanical work during the adiabatic expansion of a unit weight of steam.

Adobe

A building material made from clay, straw, and water, formed into blocks, and dried.

Air Conditioner

A device for conditioning air in an interior space. A Room Air Conditioner is a unit designed for installation in the wall or window of a room to deliver conditioned air without ducts. A Unitary Air Conditioner is composed of one or more assemblies that usually include an evaporator or cooling coil, a compressor and condenser combination, and possibly a heating apparatus. A Central Air Conditioner is designed to provide conditioned air from a central unit to a whole house with fans and ducts.

Bioenergy

The conversion of the complex carbohydrates in organic material into energy.

Biogas

A combustible gas created by anaerobic decomposition of organic material, composed primarily of methane, carbon dioxide, and hydrogen sulphide.

Biomass

Any organic matter which is available on a renewable basis, including agricultural crops and agricultural wastes and residues, wood and wood wastes and residues, animal wastes, municipal wastes, and aquatic plants.

Building Envelope

The structural elements (walls, roof, floor, foundation) of a building that encloses conditioned space; the building shell.

Building Orientation

The relationship of a building to true south, as specified by the direction of its longest axis.

Cap and Trade

Cap and trade is a policy tool. In the context of climate change the policy maker limits greenhouse gas emissions (for example for specific industries). If an emitter exceeds the "cap" it can add to its contingent by purchasing additional permits from other emitters who remain below their cap. This is seen as providing an incentive for innovation (better technology to reduce emission providing the opportunity to sell permits and/or ensuring that no permits have to be purchased). The policy maker can reduce the cap periodically.

Carbon Dioxide

A colourless, odourless non-combustible gas with the formula CO_2 that is present in the atmosphere. It is formed by the combustion of carbon and carbon compounds (such as fossil fuels and biomass), by respiration, which is a slow combustion in animals and plants, and by the gradual oxidation of organic matter in the soil.

Carbon footprint

The amount of carbon emitted by an individual or organisation in a given period of time, or the amount of carbon emitted during the manufacture of a product.

Climate

The prevailing or average weather conditions of a geographic region.

Climate Change

A term used to describe short and long-term affects on the Earth's climate as a result of human activities such as fossil fuel combustion and vegetation clearing and burning.

Codes

Legal documents that regulate construction to protect the health, safety, and welfare of people. Codes establish minimum standards but do not guarantee efficiency or quality.

Coefficient of Heat Transmission (U-Value)

A value that describes the ability of a material to conduct heat. The number of Btu that flows through 1 square foot of material, in one hour. It is the reciprocal of the R-Value ($\text{U-Value} = 1/\text{R-Value}$).

Comfort Zone

A frequently used room or area that is maintained at a more comfortable level than the rest of the house; also known as a "warm room."

Condensation

The process by which water in air changes from a vapour to a liquid due to a change in temperature or pressure. Occurs when water vapour reaches its dew point (condensation point). Also used to express the existence of liquid water on a surface.

Conduction

The transfer of heat through a material by the transfer of kinetic energy from particle to particle. The flow of heat between two materials of different temperatures that are in direct physical contact.

Convection

The transfer of heat by means of air currents.

Cooling Load

That amount of cooling energy to be supplied (or heat and humidity removed) based on the sensible and latent loads.

Cooling Tower

A structure used to cool power plant water; water is pumped to the top of the tubular tower and sprayed out into the centre, and is cooled by evaporation as it falls, and then is either recycled within the plant or is discharged.

Dehumidifier

A device that cools air by removing moisture from it.

Double-Pane or Glazed Window

A type of window having two layers (panes or glazing) of glass separated by an air space. Each layer of glass and surrounding air space reradiates and traps some of the heat that passes through thereby increasing the windows resistance to heat loss (R-value).

Earth Cooling Tube

A long, underground metal or plastic pipe through which air is drawn. As air travels through the pipe it gives up some of its heat to the soil, and enters the house as cooler air.

Efficiency

Efficiency is the ratio of work or energy output to work or energy input, and cannot exceed 100 percent. Efficiency under the Second Law of Thermodynamics is determined by the ratio of the theoretical minimum energy that is required to accomplish a task relative to the energy actually consumed to accomplish the task.

Emission(s)

A substance(s) or pollutant emitted as a result of a process.

Emission Trading Scheme (ETS)

A scheme set up to allow the trading of emissions permits between business and/or countries as part of a cap and trade approach to limiting greenhouse gas emissions. The best-developed example is the EU's trading scheme, launched in 2005. See Cap and trade.

Energy

The capability of doing work; different forms of energy can be converted to other forms, but the total amount of energy remains the same.

Energy Audit

A survey that shows how much energy you use in your house or apartment. It will help you find ways to use less energy.

Energy Efficient Mortgages

A type of home mortgage that takes into account the energy savings of a home that has cost-effective energy saving improvements that will reduce energy costs thereby allowing the homeowner to more income to the mortgage payment. A borrower can qualify for a larger loan amount than otherwise would be possible.

Energy Efficiency Ratio (EER)

The measure of the instantaneous energy efficiency of room air conditioners; the cooling capacity in Btu/hr divided by the watts of power consumed at a specific outdoor temperature (usually 95 degrees Fahrenheit).

Energy Guide Labels

The labels placed on appliances to enable consumers to compare appliance energy efficiency and energy consumption under specified test conditions as required by the Federal Trade Commission.

Energy Storage

The process of storing, or converting energy from one form to another, for later use. Storage devices and systems include batteries, conventional and pumped storage hydroelectric, flywheels, compressed gas, and thermal mass.

Evaporative Cooling

The physical process by which a liquid or solid is transformed into the gaseous state. For this process a mechanical device uses the outside air's heat to evaporate water that is held by pads inside the cooler. The heat is drawn out of the air through this process and the cooled air is blown into the home by the cooler's fan.

Externality

The environmental, social, and economic impacts of producing a good or service that are not directly reflected in the market price of the good or service.

Fly Ash

The fine particulate matter entrained in the flue gases of a combustion power plant.

Fossil Fuels

Fuels formed in the ground from the remains of dead plants and animals. It takes millions of years to form fossil fuels. Crude oil, natural gas, and coal are fossil fuels.

Geothermal Energy

Energy produced by the internal heat of the earth. Geothermal heat sources include hydrothermal convective systems, pressurized water reservoirs, hot dry rocks, manual gradients and magma. Geothermal energy can be used directly for heating or to produce electric power.

Geothermal Heat Pump

A type of heat pump that uses the ground, ground water, or ponds as a heat source and heat sink, rather than outside air. Ground or water temperatures are more constant and are warmer in winter and cooler in summer than air temperatures. Geothermal heat pumps operate more efficiently than "conventional" or "air source" heat pumps.

Global Warming

A popular term used to describe the increase in average global temperatures due to the greenhouse effect.

Green Certificates

Green certificates represent the environmental attributes of power produced from renewable resources. By separating the environmental attributes from the power, clean power generators are able to sell the electricity they produce to power providers at a competitive market value. The additional revenue generated by the sale of the green certificates covers the above-market costs associated with producing power made from renewable energy sources. Also known as green tags, renewable energy certificates, or tradable renewable certificates.

Greenhouse Gases

Those gases, such as water vapour, carbon dioxide, tropospheric ozone, methane, and low level ozone that are transparent to solar radiation, but opaque to long wave radiation, and which contribute to the greenhouse effect.

Greenhouse Effect

The insulating effect of certain gases in the atmosphere, which allow solar radiation to warm the earth and then prevent some of the heat from escaping. See also natural greenhouse effect.

Humidity

A measure of the moisture content of air. May be expressed as absolute, mixing ratio, saturation deficit, relative, or specific quantity.

Insulation

Materials that prevent or slow down the movement of heat.

IPCC

The Intergovernmental Panel on Climate Change is a scientific body established by the United Nations Environment Programme and the World Meteorological Organization. It reviews and assesses the most recent scientific, technical, and socio-economic work relevant to climate change, but does not carry out its own research. The IPCC was honoured with the 2007 Nobel Peace Prize.

Kyoto Protocol

A protocol attached to the UN Framework Convention on Climate Change, which sets legally binding commitments on greenhouse gas emissions. Industrialised countries agreed to reduce their combined emissions to 5.2% below 1990 levels during the five-year period 2008-2012. It was agreed by governments at a 1997 UN conference in Kyoto, Japan, but did not legally come into force until 2005.

Life Cycle Cost

The sum of all the costs, recurring and nonrecurring, related to a product, structure, system, or service during its life span or specified time period.

Microclimate

The local climate of specific place or habitat, as influenced by landscape features.

Mitigation

Action that will reduce man-made climate change. This includes action to reduce greenhouse gas emissions or absorb greenhouse gases in the atmosphere.

Natural Ventilation

Ventilation that is created by the differences in the distribution of air pressures around a building. Air moves from areas of high pressure to areas of low pressure with gravity and wind pressure affecting the airflow. The placement and control of doors and windows alters natural ventilation patterns.

Orientation

The alignment of a building along a given axis to face a specific geographical direction. The alignment of a solar collector, in number of degrees east or west of true south.

Passive/Natural Cooling

To allow or augment the natural movement of cooler air from exterior, shaded areas of a building through or around a building.

Passive Solar (Building) Design

A building design that uses structural elements of a building to heat and cool a building, without the use of mechanical equipment, which requires careful consideration of the local climate and solar energy resource, building orientation, and landscape features, to name a few. The

principal elements include proper building orientation, proper window sizing and placement and design of window overhangs to reduce summer heat gain and ensure winter heat gain, and proper sizing of thermal energy storage mass (for example a Trombe wall or masonry tiles). The heat is distributed primarily by natural convection and radiation, though fans can also be used to circulate room air or ensure proper ventilation.

Payback Period

The amount of time required before the savings resulting from your system equal the system cost.

Phase-Change Material

A material that can be used to store thermal energy as latent heat. Various types of materials have been and are being investigated such as inorganic salts, eutectic compounds, and paraffin for a variety of applications including solar energy storage (solar energy heats and melts the material during the day and at night it releases the stored heat and reverts to a solid state).

Photovoltaic (Solar) Module or Panel

A solar photovoltaic product that generally consists of groups of PV cells electrically connected together to produce a specified power output under standard test conditions, mounted on a substrate, sealed with an encapsulant, and covered with a protective glazing. Maybe further mounted on an aluminium frame. A junction box, on the back or underside of the module is used to allow for connecting the module circuit conductors to external conductors.

ppm (350/450)

An abbreviation for parts per million, usually used as short for ppmv (parts per million by volume). The Intergovernmental Panel on Climate Change (IPCC) suggested in 2007 that the world should aim to stabilise greenhouse gas levels at 450 ppm CO₂ equivalent in order to avert dangerous climate change. Some scientists, and many of the countries most vulnerable to climate change, argue that the safe upper limit is 350ppm. Current levels of CO₂ only are about 380ppm.

Power

Energy that is capable or available for doing work; the time rate at which work is performed, measured in horsepower, Watts, or Btu per hour. Electric power is the product of electric current and electromotive force.

Radiator

A room heat delivery (or exchanger) component of a hydronic (hot water or steam) heating system; hot water or steam is delivered to it by natural convection or by a pump from a boiler.

Recycling

The process of converting materials that are no longer useful as designed or intended into a new product.

Renewable Energy

Energy derived from resources that are regenerative or for all practical purposes can not be depleted. Types of renewable energy resources include moving water (hydro, tidal and wave power), thermal gradients in ocean water, biomass, geothermal energy, solar energy, and wind energy. Municipal solid waste (MSW) is also considered to be a renewable energy resource.

Resilience

In ecology, resilience is the capacity of an ecosystem to respond to a perturbation or disturbance by resisting damage and recovering quickly.

R-Value

A measure of the capacity of a material to resist heat transfer. The R-Value is the reciprocal of the conductivity of a material (U-Value). The larger the R-Value of a material, the greater its insulating properties.

Shutter

An interior or exterior movable panel that operates on hinges or slides into place, used to protect windows or provide privacy.

Solar Cooling

The use of solar thermal energy or solar electricity to power a cooling appliance. There are five basic types of solar cooling technologies: absorption cooling, which can use solar thermal energy to vaporize the refrigerant; desiccant cooling, which can use solar thermal energy to regenerate (dry) the desiccant; vapour compression cooling, which can use solar thermal energy to operate a Rankine-cycle heat engine; and evaporative coolers ("swamp" coolers), and heat-pumps and air conditioners that can be powered

Temperature Zones

Individual rooms or zones in a building where temperature is controlled separately from other rooms or zones.

Thermal Energy Storage

The storage of heat energy during power provider off-peak times at night, for use during the next day without incurring daytime peak electric rates.

Transmission

The process of sending or moving electricity from one point to another; usually defines that part of an electric power provider's electric power lines from the power plant buss to the last transformer before the customer's connection.

U-Value

The reciprocal of R-Value. The lower the number, the greater the heat transfer resistance (insulating) characteristics of the material.

Vulnerability

Vulnerability refers to the inability to withstand the effects of a hostile environment.

Wind Energy

Energy available from the movement of the wind across a landscape caused by the heating of the atmosphere, earth, and oceans by the sun.

Zoning

The combining of rooms in a structure according to similar heating and cooling patterns. Zoning requires using more than one thermostat to control heating, cooling, and ventilation equipment.

Zero-Energy Building

A building with a net energy consumption of zero over a typical year because the energy provided by on-site renewable energy sources is equal to the energy used. Buildings approaching this goal also may be called zero-emission or zero-carbon buildings.