Lecture 1: Introduction

21st Century Challenges to combat increased human population

- water
- urbanisation
- food
- energy
- biofuels
- health
- environment
- terrorism/conflict
- climate change
- food wastage
- hunger
- policy and governance
- well-being
- sustainability

The Anthropocene

Anthropocene is the geological age/era of the Earth that we are living in right now

- Anthro = human; "human era"
- the term describes the era starting from around 250 years ago, i.e. around 1750s onwards
- the term is proposed in the year 2000 by nobel prize winner (chemist) Paul Crutzen

Why proposed the term 'Anthropocene'?

- Humans are disturbing the planet Earth significantly. There is an increase in human population, thus increase in human activities that affects the climate or sustainability.
- It is an era whereby human activities are dominant.

Evidence

1. **Socio-economic trends have elevated.**
   It is natural for the trend to increase with the increase in human population as there are more humans consuming more food, more water (by making dams), increased in fertiliser use etc.

2. **Earth system trends also elevates.**
   With the acceleration in human activities, there are more greenhouse gases emissions (resulting in increased temperatures), more deforestation (domesticating land for human use) and other human activities that are having adverse effects on our planet.
   - Food production is the main cause of environmental change and degradation. A lot of the greenhouse gases are produced by agricultural activities from animal production and excessive fertiliser use.

3. **CLIMATE CHANGE?**
   Are we transgressing the safe boundaries for humanity? Yes. Some of the parameters that suggest climate change are already way beyond normal. We know that the planet can sustain itself whether humans are here or not. Thus if we transgress more boundaries, will humans still live on Earth in the future?

Population Growth

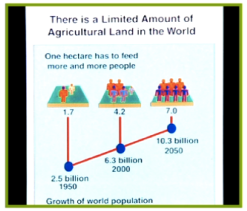
Human population around 10,000BC was about 6-8 million. By the time of Christ, 100-300 million. When Columbus landed in the New World, 450 million. When new science of chemistry entered agriculture (late 1700s), it has doubled to 900 million. Today, there are about 7.5 billion people.

- 1950s onwards, fertilisers were used. Thus see in a dramatic increase in human population.
- population increase is seen in less-developed regions; whereas in more developed regions, population is steady
  - except Japan: decline in population

Reasons for population growth:

1. more birth rates
2. life expectancy has increased, thus people are living longer

Available Land



Available Land

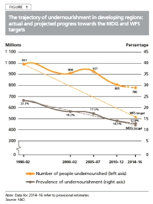
- agricultural land is limited in the world. The same size land has to feed more people as world population increases.

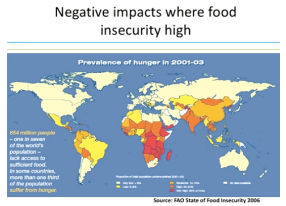
Food Insecurity vs. Obesity Epidemic

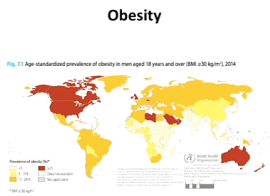
- 1 in 8 people goes to sleep hungry every day
- Food insecurity arises from production insecurity and economic insecurities. Food insecurity is not only due to lack of food production, it can also be because people are too poor to afford food, or due to transport issues.
- Right now, we produce enough food for every individual in the world.

Undernutrition

- undernutrition = undernourished
- mostly in the poorer less-developed regions, e.g. in Sub-Saharan Africa and South Asia
- reality: either no food (hunger) or too much food (obesity)
- obesity: more than 25% of population are obese (BMI more than 30), e.g. in USA and Australia





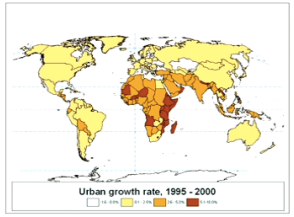


Feeding the Population

- 35% of planet's surface are used for food production (more than forested area)
- it is impossible to separate agricultural practices from the health of ricers, wetlands, forests and the living environment
- our food choices rival transportation as the human activity with the greatest impact on the environment

Urbanisation

- By 2050, 70% of world's population will live in urban areas and this is associated with the "march to the cities"
- urbanisation of poverty and food insecurity
    - many people whom are involved in agriculture and food production are declining, whereas consumers are increasing

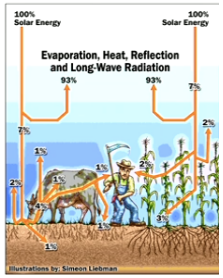


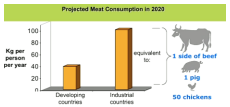
Animal Protein

- global meat production has increased more than fivefold since 1950
- more people are able to afford meat (protein rich sources)
- poorer people tend to consume more grains/rice as main food
- 1kg of beef uses 15,500 L of water

Problems with consuming animal protein

- productive energy is diminished with each trophic level
- plants thrive on solar energy. They undergo photosynthesis with sunlight to produce carbohydrates.
- The grains are then used to feed animals (cattle) as meat production. This is a highly inefficient process as many more people could be fed by the grain used to feed the cattle than can be fed by the cattle themselves.
- fun fact: the amount of energy needed to produce a single hamburger is enough to power a small car for 30km
- Also, cattle contributes to the greenhouse emissions (methane).





There are also **other looming stresses — Peak Oil, Water Shortages, Climate Change**, that comes with the increase in animal production, foreshadowing further food production constraints, price rises and increased political unrest unless dealt with.

Peak Oil

- 20 largest oil fields were discovered between 1917 and 1979
- since 1981, oil extraction has exceeded new discoveries by a widening margin
- most of the easily recovered oil is already pumped
- once oil production turns downward, countries will compete for a shrinking supply. It will be far more difficult to expand energy-intensive agricultural production when the price of oil is rising and the supply is declining.

Water Shortages

- 2.5% of Earth's water is freshwater and only 1.2% of all freshwater is surface water (that is available to us)
- takes a lot of water to produce meat (are there any other ways? — plant-based meat)
- Irrigation leading to severe water shortages.

- in India, they pump the water out from underground. Pumping of water needs energy — fossil oil, fossil fuel, or electricity (coal and other fuels). The water underground takes hundreds of years to accumulate. There are replenishable and non-replenishable water layers. Pumping water from the non-replenishable source is not a sustainable way to produce food. It is only best if we pump the water at the rate it is replenished by rain.

Climate Change

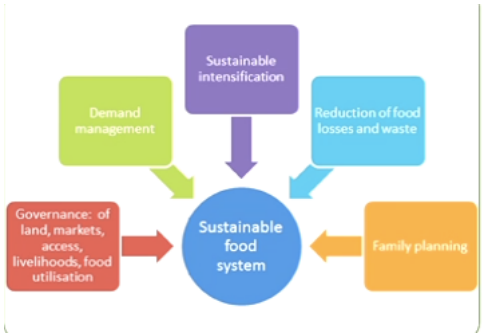
- if temperature increases by about 2 degrees, there will be a sharp decline in food availability
    - hotter climate reduces yield
- evolution cannot keep up
    - plants are used to certain temperatures to thrive well in

Other problems

- biofuels
    - using maize, sugar cane for biofuels (ethanol), instead of feeding the population
- food waste
    - 25-50% of food is wasted globally through crops not being harvested, losses during transportation, discarded by marketers or retailers, and household wastes (AUD$5.2 billion; 35% of municipal waste is food waste)
    - causes include:
        - over-production and rejection at farm-gate
        - long distance transportation
        - retailer power and market forces
        - consumer aesthetics and preferences
        - food safety and litigation concerns
        - excessive purchasing and low cost of food

How to increase food production: SUSTAINABLE INTENSIFICATION

- we still need to find ways to produce food in a sustainable way, without using more land (not enough land)
- Foley's 5 step:
    1. freeze agriculture's footprint
    2. grow more on farms we've got
    3. use resources more efficiently
    4. shift diets
    5. reduce waste
- Organic food vs. Genetically Modified food
    - Organic food does not use artificial fertilisers, pesticides; but it is not really better.
    - Lots of GM food are produced under less pesticides, fertiliser and water.



Lecture 2: You are what you eat — Food, nutrition and human health

Ultimately, all the food comes from plants.
- the meat in our diet comes from animals that eat plants
- we are not autotrophs like plants; as heterotrophs, we need to eat for energy

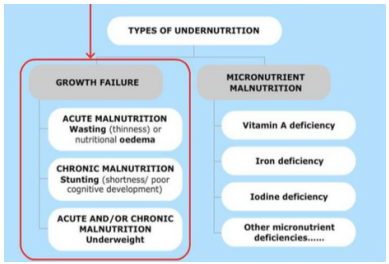
Reasons of why we eat
- sensual/physiological reasons (smells/looks/tastes good, I'm hungry, I'm tired)
- social/emotional reasons (favourite dish, traditional dish, birthday, I'm depressed)
- economic reasons (what we can afford, time efficiency)
- media and marketing (superfood, multivitamin pill, detox, carbohydrates are bad/good, organic)

Double burden of Malnutrition
- the double burden of malnutrition is characterised by the coexistence of undernutrition along with overweight and obesity, or diet-related non-communicable diseases, within individuals, household and populations, and across the life course
- 795 million people are hungry; 1.9 billion people overweight and obesity

Malnutrition comes in all forms, such as:
- child stunting (low height for age)
- child wasting (low weight for height)
- child overweight (high weight for height)
- adult overweight (excess body fat with a body mass index BMI over 25)
- adult obesity (excess body fat with a body mass index BMI over 30)
- micronutrient deficiency (iron, folic acid, vitamin A, zinc, iodine below healthy thresholds)
- non-communicable disease (diabetes, heart disease and some cancers)

Micronutrient deficiencies
- occur in both developed and developing world
    - developing world: having not enough/not a wide range of foods
    - developed world: having high caloric, highly processed, non-nutritious foods
- micronutrients includes vitamins and minerals, which are essential small molecules
    - vitamins are essential as we cannot synthesise them (need to eat them)
    - Vitamin A
    - Vitamin B1, thiamine
    - Vitamin B3, niacin
    - Vitamin B9, folate
    - Vitamin C, ascorbic acid
- micronutrient deficiencies can affect a range of body functions
    - immunity: more severe illness, more infant and maternal deaths
    - stunted growth
    - lower work productivity
    - higher morbidity/mortality

    - lower cognitive ability
    - brain development
    - reproduction



Zinc Deficiency
- impairs growth in children

Vitamin A Deficiency
- leading cause of blindness
    - 100 million children are Vitamin A deficient
    - up to 500,000 children become blind every year and half of these die within 12 months of losing their sight
    - improving dietary intake of carotenes can reduce child mortality by 25%

Vitamin D Deficiency
- due to human factors
    - amount of skin exposure to the sun and duration of exposure
    - sunscreen protection, cloth coverage, social and religious customs
    - degree of melanin concentration
- due to decreased amount of **UV-B** reaching the Earth
    - depends on season of the year, time of day, pollution, clouds, distance from equator
- vitamin D synthesis needs sunlight; kidney then can make 1,25-dihydroxyvitamin D3 which is important in maintaining calcium balance in the body
- food sources: cheese, margarine, butter, fortified milk, healthy cereals, fatty fish
    - vitamin D3 (fish, meat)
    - vitamin D2 (supplements)

Solving the problem of Micronutrient deficiency
Prevention through
- dietary diversification
    - increase intake from available and accessible foods
    - nutrition education (healthy eating pyramid)
    - social marketing
    - community garden programs
    - measures to improve food security
- fortification
    - e.g. iodised sea salt, vitamins A & D fortified in margarine, vitamin D in milk
- biofortification
    - the development of nutrient dense staple crops using the best conventional breeding practices and modern biotechnology
    - biofortification since most of our staple foods are poor in essential micronutrients
    - e.g. fortified with iron, zinc, calcium, pro-vitamin A carotenoids, folate, amino acids, probiotics etc.