EN2001 Sem 1 Examination 2012-2013

1\. (a) ① period 1: slow population growth due to high birth rates & high death rates offsetting

② period 2: rapid population growth as death rates decline due to country modernizing (better sanitation, health care, more food) while birth rates remain high

③ period 3: stable population growth - as economy & education systems improve, birth rates tend to fall

④ period 4: declining population growth, characteristic of high level of affluence and economic development

(b) ① Virtual water: water used to produce a product.

② Virtual water trading via goods can alleviate (or even hide) national water scarcity but also increase national water dependency. Redistribution of water can be achieved via virtual water in international trade.

(c) (i) $P(5) = P_0 \cdot e^{rt}$

$= 200 \cdot e^{3\% \times 5}$

$= 232.3668$ millions

$P(10) = P(5)(1+r)^t$

$= 232.3668 \times (1+2.5\%)^5$

$= 262.902$ million

(ii) Doubling time for exponential growth

$t_d = \frac{\ln 2}{3\%} = 23.105$ years

Doubling time for annual growth

$(1+2.5\%)^t = 2$

$t = \frac{\ln 2}{\ln(1+2.5\%)} = 28.071$ years

$(1+d)^{23.105} = 2$

$23.105 = \frac{\ln 2}{\ln(1+d)}$

$\ln(1+d) = \frac{\ln 2}{23.105}$

~~$d = 3.045\%$~~

Yes, U Can!

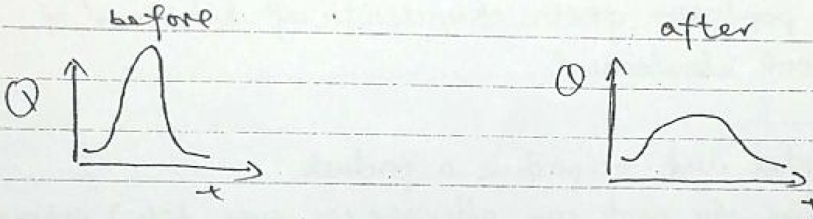
2. (a) ① increased runoff volumes & peak flow rates because of increased impervious cover of the urban watershed

② increased runoff because of increased hydraulic efficiency associated with artificial (man-made) channels and storm drainage collection systems

③ acceleration of stream velocities and degradation of stream channels

④ increased flooding

Hydrographs



(b) (i) $Q_{catch} = 0.0028\,CiA$

$= 0.0028 \times 100\,mm/h \times 0.2 \times 50$

$= 2.8\ m^3/s$

$Q_{lot} = 0.0028\,CiA$

$= 0.0028 \times 100\,mm/h \times 0.8 \times 12$

$= 2.688\ m^3/s$.

(ii) for catchment:

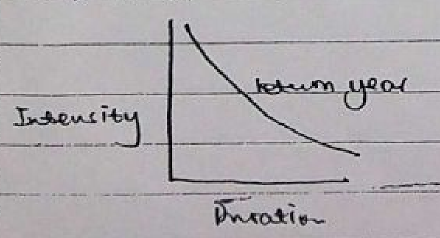
$$t_c = \frac{1.8(1.1-0.2)\sqrt{3.28 \times 2000}}{3^{\frac{1}{3}}}$$

$= 90.98\ min$

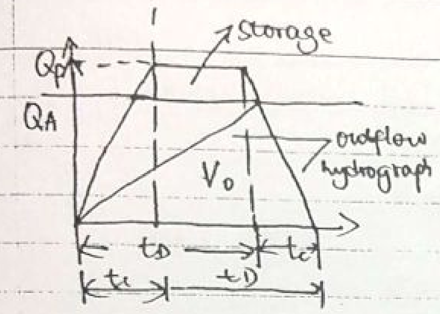
for parking lot

$$t_c = \frac{1.8(1.1-0.8)\sqrt{3.28 \times 400}}{3^{\frac{1}{3}}} = 13.56\,min.$$

(iii) IDF curve



Knowing the durationd and return period, the rainfall density



Storage needed: Vs

$V_s = V_i - V_o$

$V_i = Q_p t_d$ inflow volum

$V_o = 0.5 Q_A (t_D + t_c)$

Q_A: maximum allowable release rate

To find runoff discharge, we need to consider the outflow, which is V_o, given by t_c, t_D, Q_A. The graph can be obtained by setting constant peak flow rate using rational formula and IDF curves assuming different storm duration t_D, return period T and intensity.

3. (a) Impact on crops:

(1) higher CO_2 levels may increase yields but be ~~counteract~~ counteracted by high temperature or shortage of water

(2) drought problem

Impact on livestock

(1) heat waves threaten livestock health

(2) prevalence of parasite and diseases

Impact on Fishery

(1) fish reproduction and migration

(2) aquatic diseases

(b) (i) T = 50

$p = \frac{1}{T} = 0.02$

if the ~~propability~~ double

$p' = 0.04$

$P(X \geq 2) = 1 - P(X<2)$

$= 1 - P(X=0) - P(X=1)$

~~$= 1 - (1-0.04)^{10} - {}_{10}C_1 (1-0.04)^{9} \, 0.04$~~ $= 1 - (1-0.02)^{10} - {}_{10}C_1 (1-0.02)^{9} \cdot 0.02$

$10 \times (1-0.02)^{9} \times 0.02$

$= 0.0162$

~~$= 0.0582$~~ $= 0.166$

(ii) $P'(X \geq 2) = 1 - P'(X<2)$

$= 1 - P'(X=0) - P'(X=1)$

$= 0.0582$

(iii) $T = 100$

$p = \frac{1}{T} = 0.01$

$P(X=1) = {}_{20}C_1 (1-0.01)^{19}\, 0.01$

$= 0.165$

(c) Emission trading:

mechanism allows parties to the Kyoto Protocol to buy 'Kyoto Units' (emission permits for greenhouse gas) from other countries to help meet their domestic emission reduction targets.

Downscaling: A way to obtain higher spatial resolution output based on GCMs.

Emission Scenario A1: It's based globalization scale, focusing on economic more (rapid economic growth).

4. (a) ① Benefits to industry:

1) eco-industrial park offers the opportunity to decrease production costs
2) support small and medium size firms to gain access to information

② Benefits to environment:

1) reduce source of pollution and waste. as well as decrease demand for natural resources

③ Benefits to society

1) creat new jobs
2) development of eco-industrial parks will create programs for extending their economic and environmental benefits across a a community's whole industrial sector.

(b) An "emerging contaminant" is a chemical or material that is characterized by a perceived, potential, or real threat to human health or the ~~environment or a lack~~ of published health standards

A contaminant may also be "emerging" because a new source or a new pathway to humans has been discovered or a new detection method or treatment technology has been developed

4(b)

Characteristics: low levels
multiple sources
long-term issue but probably not an emergency issue

List: PPCPs
Endocrine disruptors
Disinfection by-products
Brighteners in detergents
Anti-bacterial nano materials

5 (a) $m(CaO) = 40+16$
$= 56\ g/mol$
$m(CaCO_3) = 40+12+48$
$= 100\ g/mol$

$CaCO_3 + Heat \longrightarrow CaO + CO_2$
$m(CaCO_3)$ 5600 metric ton
100g/mol 56g/mol

$m(CaCO_3) = 10000$ metric ton
1 metric ton $CaCO_3 \sim 2.7\times10^6$ kJ
10^4 metric ton $CaCO_3 \sim 2.7\times10^{10}$ kJ

since half of the heat will be replaced by used tires
heat required : 1.35×10^{10} kJ
the amount of tyres required
$m = 1.35\times10^{10}\ kJ \div 32\times10^6\ kJ$ / metric ton
$= 421875\ kg$
no of tyres: $m/7.5kg = 56250$ (tyres)

(b) 1) natural source depletion — raw material mining & extraction
2) high input energy associated with high carbon footprint — primary production
3) release of GHG, aggravating the climate — product use
4) land contamination ~~due to the leak~~ of batteries discarded — end of life cycles
5) increase in landfill — end of life cycles

6.(a) to find dry sludge: 100T × 40% = 40T

carbon content for dry sludge: 40T × 80% = 32T

the digested yield: 32T × 85% = 27.2T

molecular weight: CO_2 44 g/mol 45mol%.

CH_4 16 g/mol 55mol%

assume there's 1mol biogas.

$CO_2 \sim 0.45mol \sim 19.8g$

$CH_4 \sim 0.55 mol \sim 8.8g$

to calculate biogas composition (weight

$$m\% CO_2 = \frac{19.8}{19.8+8.8} = 69.23\%$$

$$m\% CH_4 = \frac{8.8}{19.8+8.8} = 30.77\%$$

$m(CO_2) = 27.2T \times 69.23\% = 18.83T$

$m(CH_4) = 27.2T \times 30.77\% = 8.37T$

$m(CH_4)$ to produce CO_2 as fuel

$8.37 \times 3.15 = 26.36 T\ CO_2(eq)$

Total carbon reduction: $1 - \frac{26.36+18.83}{8.37\times21+18.83} = 1-23.22\% = 76.78\%$

(b) (i) solar PV

pros: 1) Singapore has a rich source of sunlight ~~through~~ all year

2) Solar energy is viewed as unlimited.

cons: 1) high temperature in Singapore will limit the efficiencies of PV cells.

2) uncertainities of the climate will also lead to loss of energy of PV cells.

(ii) solar thermal

pros: 1) higher efficiency than solar PV.

2) high temperature in Singapore

3) can use existing industrial base.

cons: 1) hot fluid ~~required~~ to power a steam turbine may increase the water burden in Singapore

2) requires large land area while Singapore is comparably small