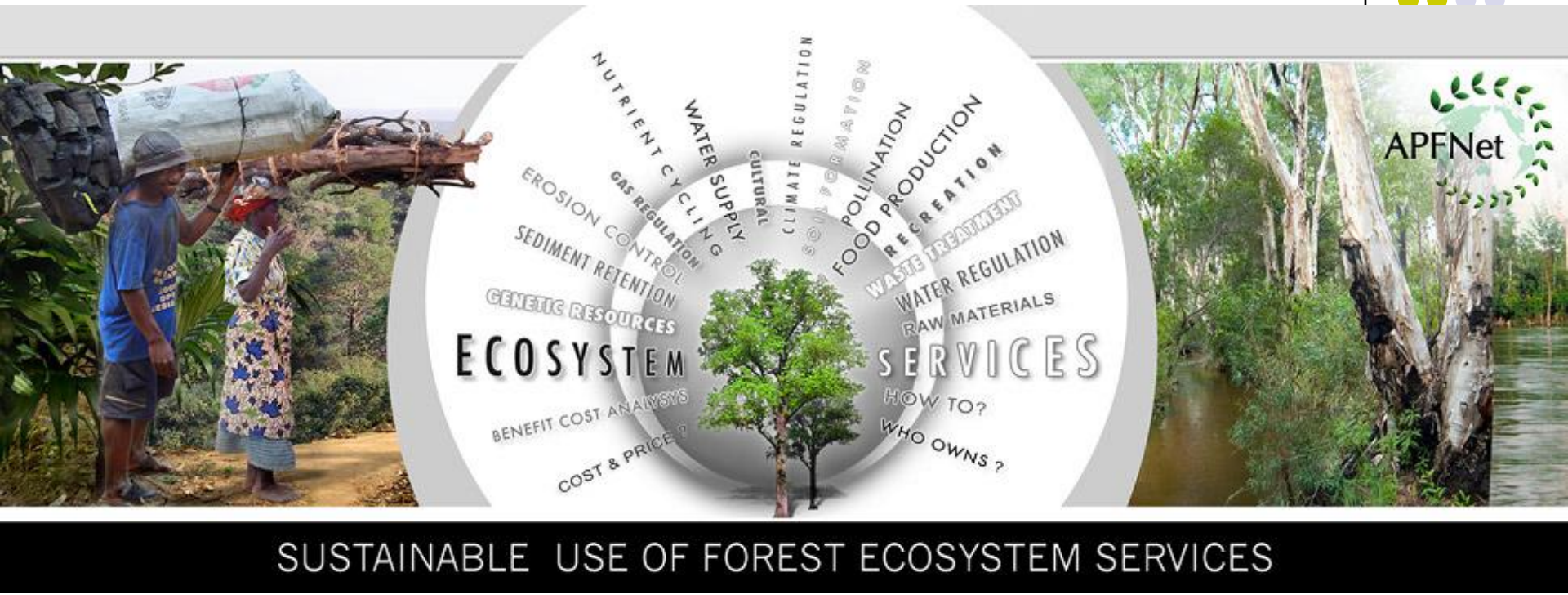
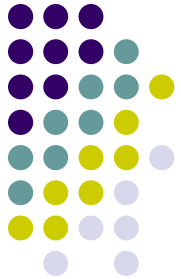



SUSTAINABLE USE OF FOREST ECOSYSTEM SERVICES

# TRAVEL COST METHOD (TCM)

# Learning Outcomes

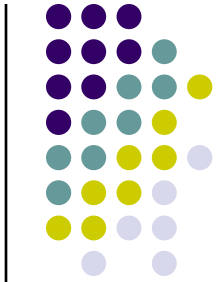


- **Explain the concept of travel cost method**
- **Prepare questionnaire to be used in TCM**
- **Apply TCM to calculate recreation benefits**

# Introduction

- TCM is used to value recreational uses of the environment
- It is commonly applied in benefit cost analyses (BCA) and in natural resource damage assessments
- It is based on ‘observed behaviour’, thus is used to estimate use values only
- TCM is a demand-based model for use of a recreation site or sites
- A site: a river for fishing, a trail for hiking, a forest camping/recreation, a park for wildlife viewing, a beach for swimming, a marine park for snorkeling, an urban park for recreation, etc

# Criteria For Recreation Valuation Procedures

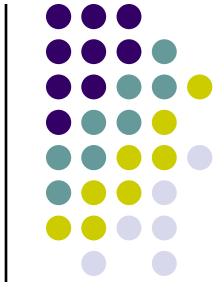


**For the efficient allocation of resources, procedure for estimating contribution of recreation should meet the following criteria:**

- Estimates of value – consistent with and have a level of precision similar to the estimates of value derived for other goods and services produced by alternative plans
- Procedures – applicable to evaluate proposed changes in the availability of the specific recreation opportunities affected by the projects being analysed
- Estimates of values of existing sites useful if the analysis is used to develop models to value a proposed change in the availability of a similar opportunities
- Individuals facing an easily accessible range of highly desirable alternatives will presumably be willing to pay less for use of a particular area than individuals with fewer and less desirable alternatives

# Criteria For Recreation Valuation Procedures

## …..cont'd



- Different values may be placed on recreation participation by different subsets of total population (may be based on income, past participation, family structure, distance, and other factors).
- If significant, they should be included in the estimation procedure
- The total level of use may be due to crowding and congestion and this affect the value of the site to an individual.
- Changes in the value due to different levels of congestion are appropriately attributed to the alternative that induced them.

# Economic Theory

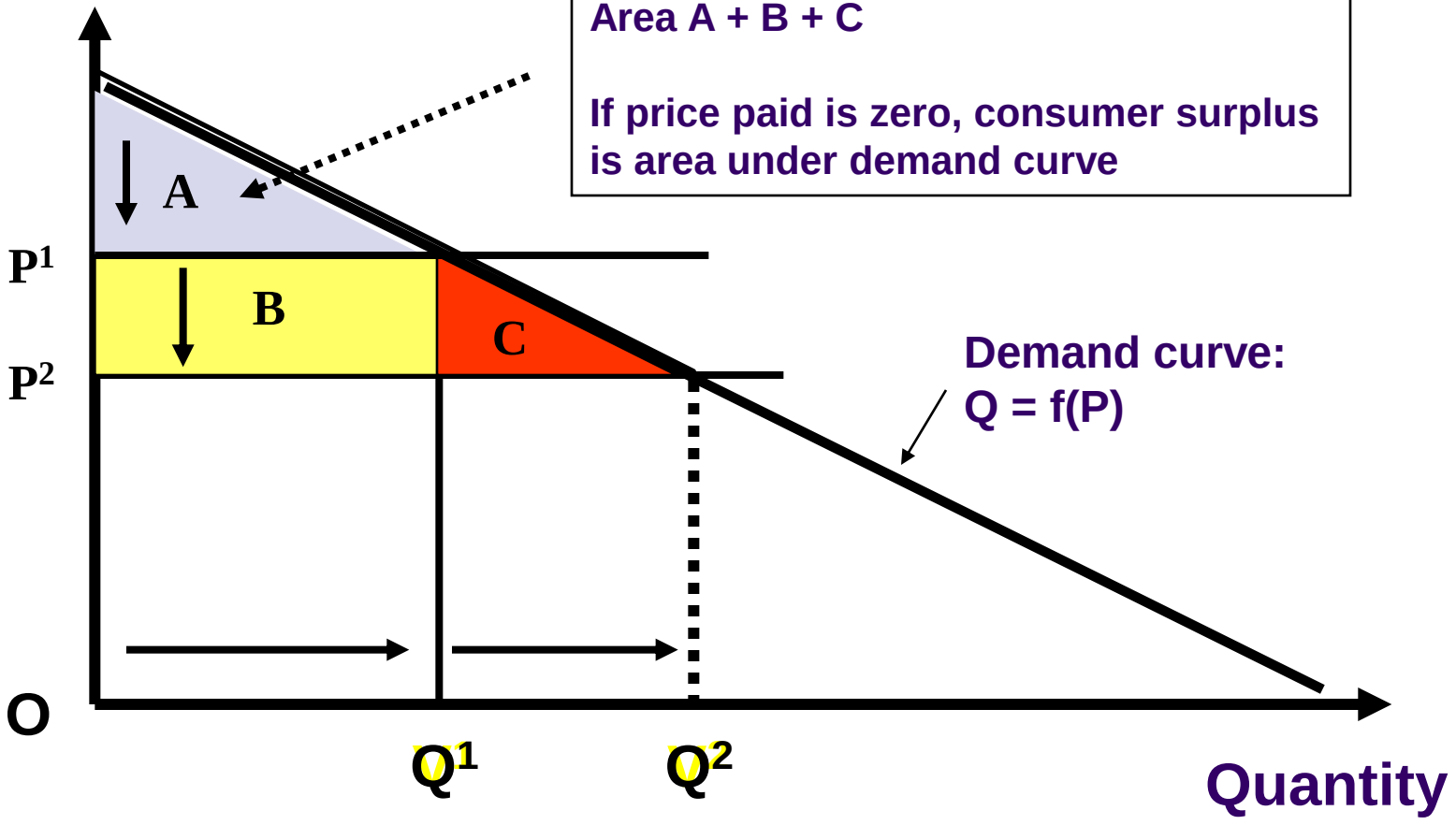
- Useful to separate between single site model and multiple site model
- For a single site model, it works like a conventional downward sloping demand functions
- The ‘quantity demanded’ – the number of trips taken to a recreation site
- The ‘price’ – the trip cost of reaching the site
- Variation in price is generated by observing people living in different distances from the site
- Price is low for people near the site and high for those living farther away
- Therefore, the demand function slopes downward if trips decline with a distance to the site. Refer to diagram

# Demand Curve and Consume Surplus

**Consumer surplus when price actually paid at $P^1$ (Area A)**

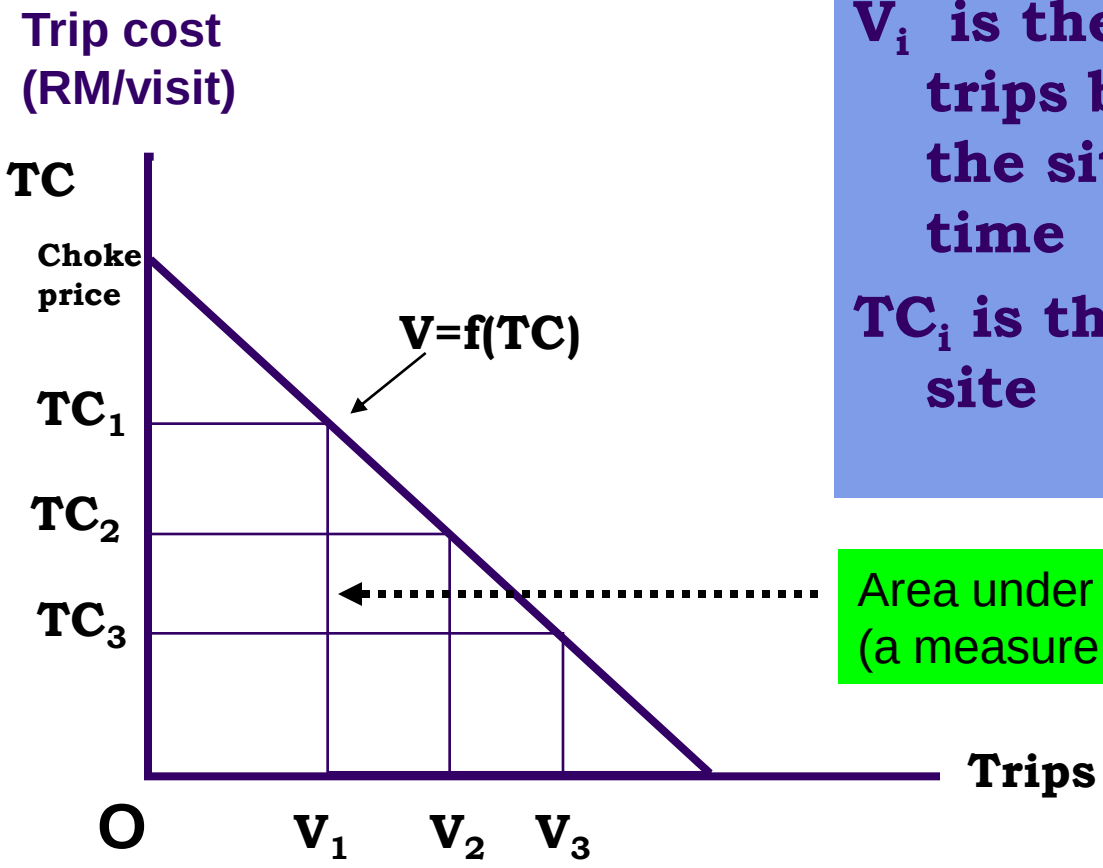
**If price paid is $P^2$, consumer surplus is Area A + B + C**

**If price paid is zero, consumer surplus is area under demand curve**



# Demand curve for recreation

$V_i = f(TC_i)$




$V_i$ is the total number of trips by individuals i to the site in a period of time

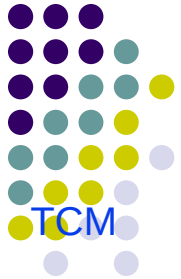
$TC_i$ is the trip cost to the site

Area under the curve = Consumer surplus (a measure of social welfare)

**Consumer surplus (Area Under the curve)**

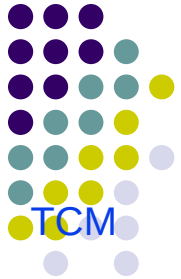
$$CS = \int_b^a (a + bTC)dTC$$

# Basic Concepts




- Travel cost method (TCM) is one of the popular methods used falls under the **revealed preference** approach to value non-priced or non-market good
- The other two approaches are: market-based and stated preference approach
- This approach is based on the assumption that the non-marketed good or service affect **preferences expressed by consumers**
- Preference of consumers are expressed in terms of **expenditure** of marketed good and service (*travel expenditure*), or in the level of productivity by certain market activities (*wage rate* or *house price*)
- The purpose is to identify the **relationship between environmental change and the affected prices** of marketed goods and services

# Basic Concepts…..




- **How this is done?**
- **Through applications of some techniques based on household production function**
- **Consumers are willing to pay for a good or service because they want to maximize utility (satisfaction)**
- **This utility is reflected in the expenditure that the consumers spend in obtaining this good or service**

# Basic Concepts

- By relating the number of visits per period to travel costs, a demand curve can be estimated that can be used to estimate the WTP of individuals for recreational services of the whole site
- The consumer surplus is used as a proxy of the WTP
- Survey of visitors is carried out using a structured questionnaire

# Basic Concepts…..

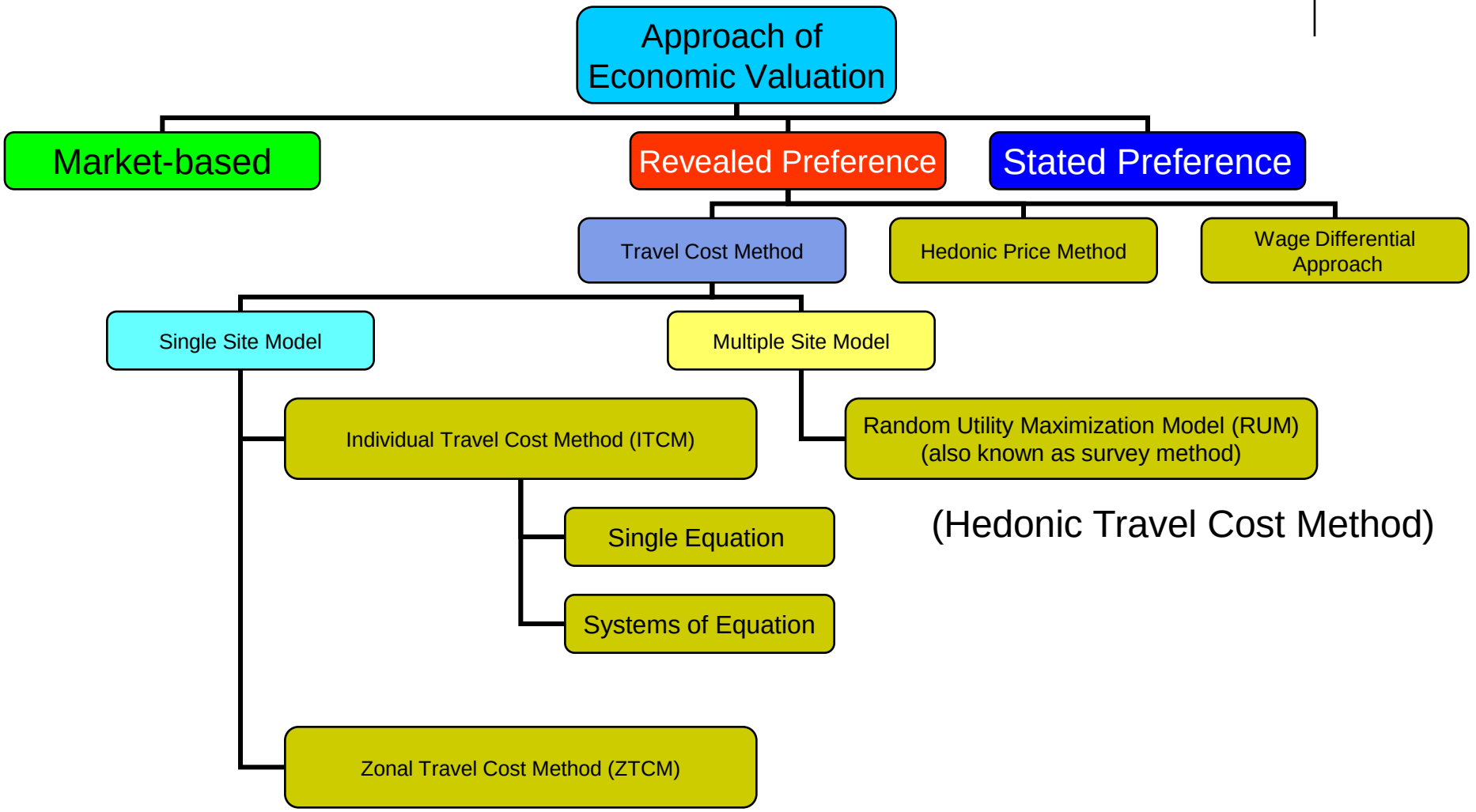

- A sample of visitors to a site is interviewed to ascertain the characteristics of their visits to the site –
  - Frequency of visits per period
  - Travel cost to the site
  - Origin of visitors
  - Socio-economic information (age, income, education, gender, household size, etc)
  - Purpose of visits

- The travel costs (including *time cost*) is a proxy for market prices in demand estimation

- Two variants of travel cost method:
  - Single site model (*Individual Travel Cost Method (ITCM) and Zonal Travel Cost Method (ZTCM).* Individual travel cost model is the most popular method.

  - Multiple site model (*Random Utility Maximization (RUM) Model or survey method – discrete choice)*

# Taxonomy of Travel Cost Method




(Hedonic Travel Cost Method)

# CONSUMER THEORY OF TCM

**Max: u ( x, v, q ) (1)**

**s.t. Monetary and Time Constraints:**

- **m + pw.tw = x + c . v (2)**
- **t* = tw + (t1 + t2) v (3)**

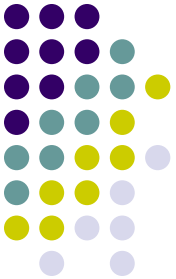
**Where**

**x = quantity of other goods consumed**
**v = number of trips to the site**
**q = environmental quality at the site**
**m = exogenous income**
**pw = wage rate**
**c = monetary cost of a trip**
**t* = total discretionary time**
**tw = hours worked**
**t1 = round trip travel time and t2 = time spent on site**

# CONSUMER THEORY

- **Two components of monetary cost for the trip:**
  - **admission fee (f)**
  - **the monetary cost of distance travel (pd.d) where**
    - **pd is the travel cost/km.**
    - **d is the distance to and from the site.**
- **Opportunity cost to time spent: wages foregone**
- **Substituting the time constraint (3) into budget constraint (2) yields (4):**
  - $m + pw.t^* = x + tc.v$ **(4)**

# CONSUMER THEORY

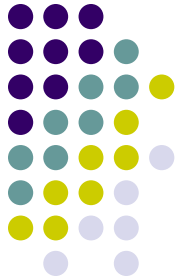


- **Where tc is the full price of a visit given by**

  **tc = c + pw ( t1 + t2 )**

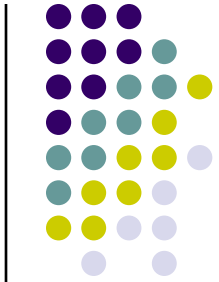
  **= f + pd.d + pw (t1 + t2 ) (5)**

- **Four components of tc:**
  - **admission fee**
  - **monetary cost of travel**
  - **time cost of travel**
  - **time cost at site**
- **Maximizing (1) s.t. Constraint (4) leads to an indvidual's demand or trip generation function (TGF) for visit v=f(M,tc,q)**



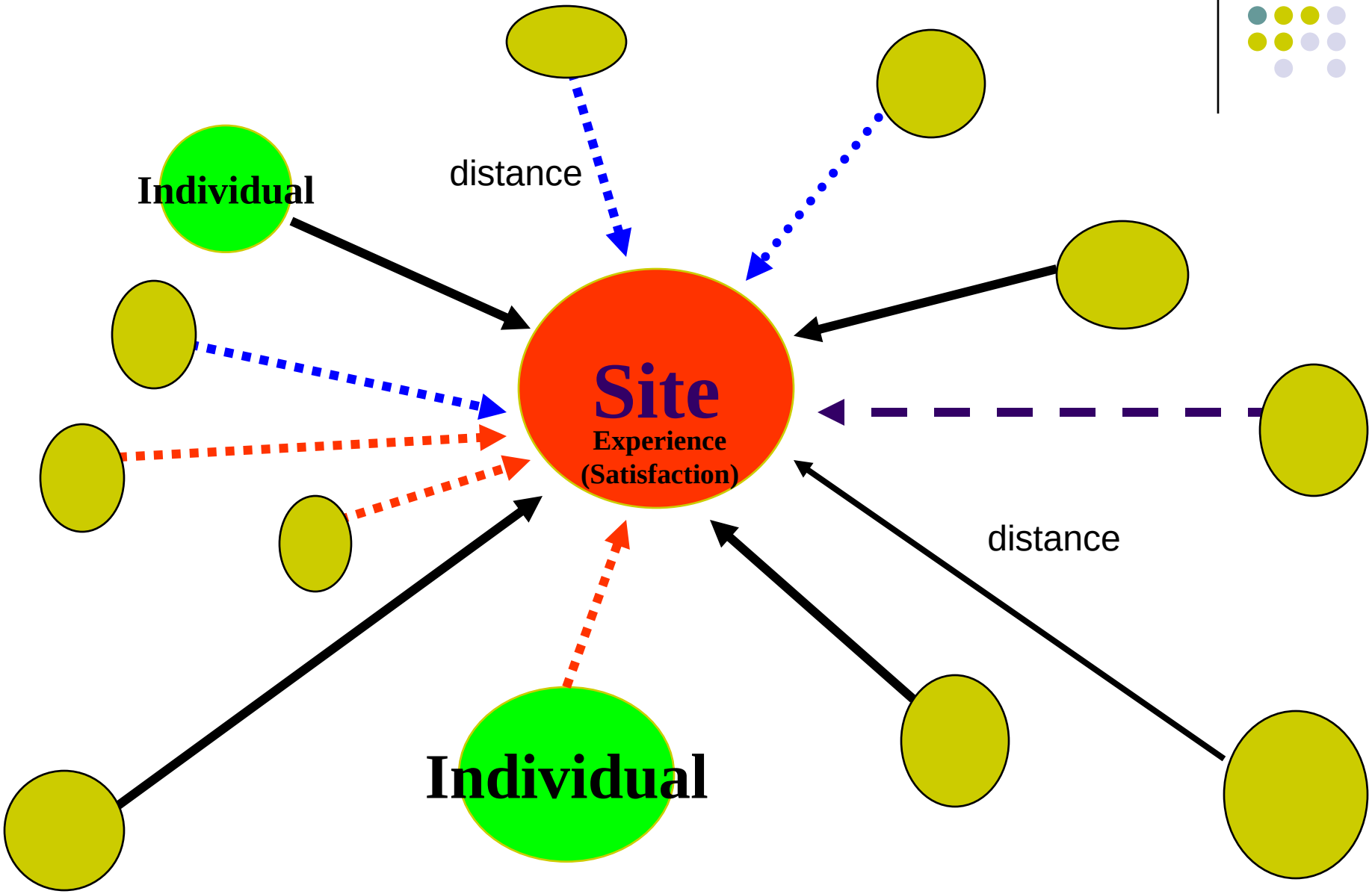
# SINGLE SITE MODEL

# Single Site Model

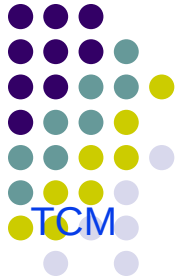


- Estimate total use of “access value”
- Use to estimate
  - Loss value – total surplus, i.e. difference between a person’s total WTP for trips and the actual trip cost over a season.
  - Examples: beach close due to oil spill, forest recreation close due to development, development project eliminate wildlife viewing
  - Value associated with a change in the cost of access to a site. E.g. increase in an entry fee, opening of new entrance, addition of new site (for example, reservoir created by a dam - more difficult to value this. Can use benefit transfer approach to estimate the value of this site from another site of similar characteristics).
  - Can also use to value changes in site characteristics (e.g. improved water quality on a lake, increase in the number hiking trails in a wilderness area). But this is the strength of single site model.
  - When the goal is to value changes in site characteristics or to vale access to more than one site simultaneously, multiple site model is preferred

# Single Site Model

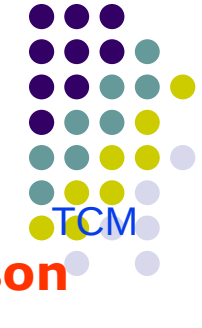


# Single Site Model- Introduction




- Is a demand model for trips to a recreation site by a person over a season
- The 'quantity demanded' – the number of trips taken to a recreation site
- The 'price' – the trip cost of reaching the site. Includes:
  - Travel expenses
  - Access fees
  - Equipment cost
  - Time cost

# Single Site Model- Basic Theory




- **The simplest form of the model is:**

**$V = f(tc_v)$, v is number of trips taken by a person in a season to the site, and $tc_v$ is the trip cost of reaching the site**

- **Relationship is negative**
- **Demand will depend on other factors: income, age, experience in the recreation activities, proximity to other recreation sites**
- **Thus, full model may be written as:**

$$V_i = f(tc_v, tc_s, y, z)$$

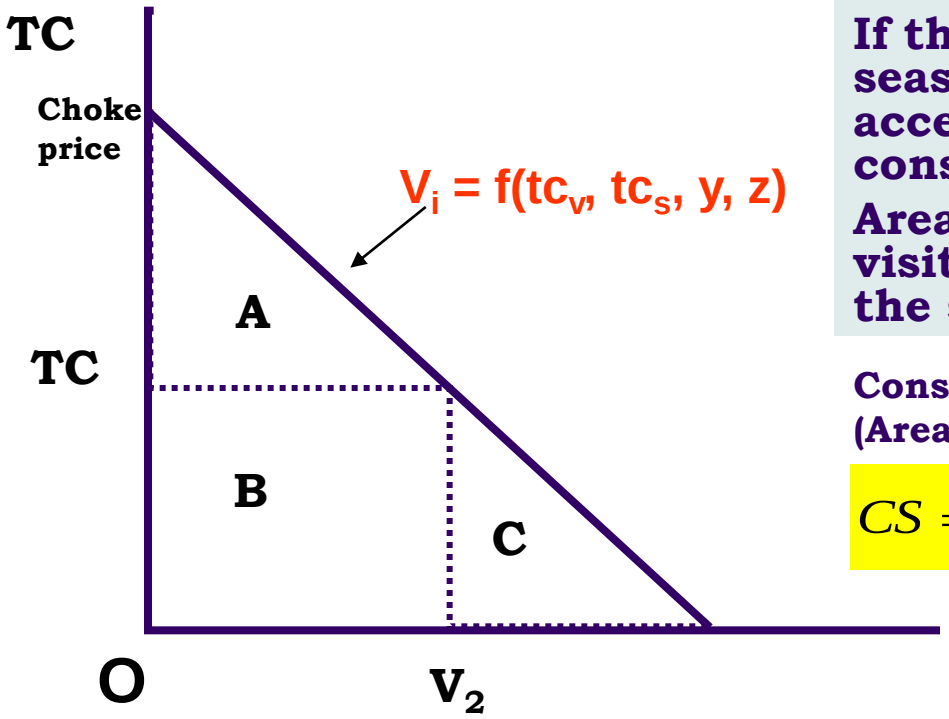
**$tc_s$ vector trip cost to other recreation sites, y is income, z is socio-economic variables of visitors i**

**$tc_s$ – positive coefficient, y – positive coefficient, z depends on variables included in the model**

**Linear equation:** $$V_i = \alpha+\beta_1*tc_i+\beta_2*tc_{si} + \beta_3* y_i + \beta_4*z_i + \varepsilon_i$$

# Access value in a linear single-site model

$V_i = f(TC_V, TC_S, y, z)$




Area A: total CS for trips to the site during the season: the difference between total willingness to pay for trips (Area A + B) d total trip cost (Area B)

This is called "individual's access value" for the site

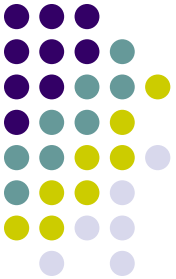
If the site were closed for the season, individual would loose access to the site and consequently the area A

Area C: Deadweight loss (if some visitors are excluded from using the site)

Consumer surplus
(Area Under the curve)

$$CS = \int_b^a (a + bTC)dTC$$

# Assumptions for demand of a single site



- **Individual Perceives Changes in Travel-related Cost of Visit the Same Way As Changes to Admission Fee**
- **Each Trip for Sole Purpose of Visiting Site (otherwise, problem of joint cost)**
- **All visit, incurs the same amount of time at site. 2 roles:**
  - **Allows measuring of site usage by the scalar 'v'.**
  - **Full price of a visit is a parameter to the individual.**
- **No utility or disutility derived from traveling time.**
- **Wage rate is the relevant opportunity cost of time**
- **No alternative recreational sites available.**

**If assumptions are not met, then the TCM model would have to be respecified.**

# Typical Form of Data Set for Estimating a Single Site Model

| Observation | No of trips to the site for the season | Trip Cost to the site (RM) | Trip cost to substitute (RM) | Monthly Income (RM) | Years engaged in this for of recreation (yrs) | No of children | Age (yrs) |
|---|---|---|---|---|---|---|---|
| 1 | 7 | 45 | 200 | 1500 | 17 | 4 | 35 |
| 2 | 1 | 120 | 20 | 800 | 2 | 0 | 24 |
| 3 | 21 | 50 | 65 | 4000 | 22 | 5 | 40 |
| . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . |
| N | 3 | 98 | 65 | 1300 | 10 | 1 | 28 |

# Steps Involved

| Step | Activity |
|---|---|
| 1 | Identification of sites of Recreation & Ecotourism Interest |
| 2 | Questionnaire Design |
| 3 | Survey of Sampled Visitors |
| 4 | Database creation and data analysis |
| 5 | WTP Estimation (Estimate of Consumer Surplus) |

# Steps Involved

**Steps**

**1: Identification of sites of Recreation & Ecotourism Interest**

1a: Assessment of recreational potential of the site

1b: Data collection of visitors flow

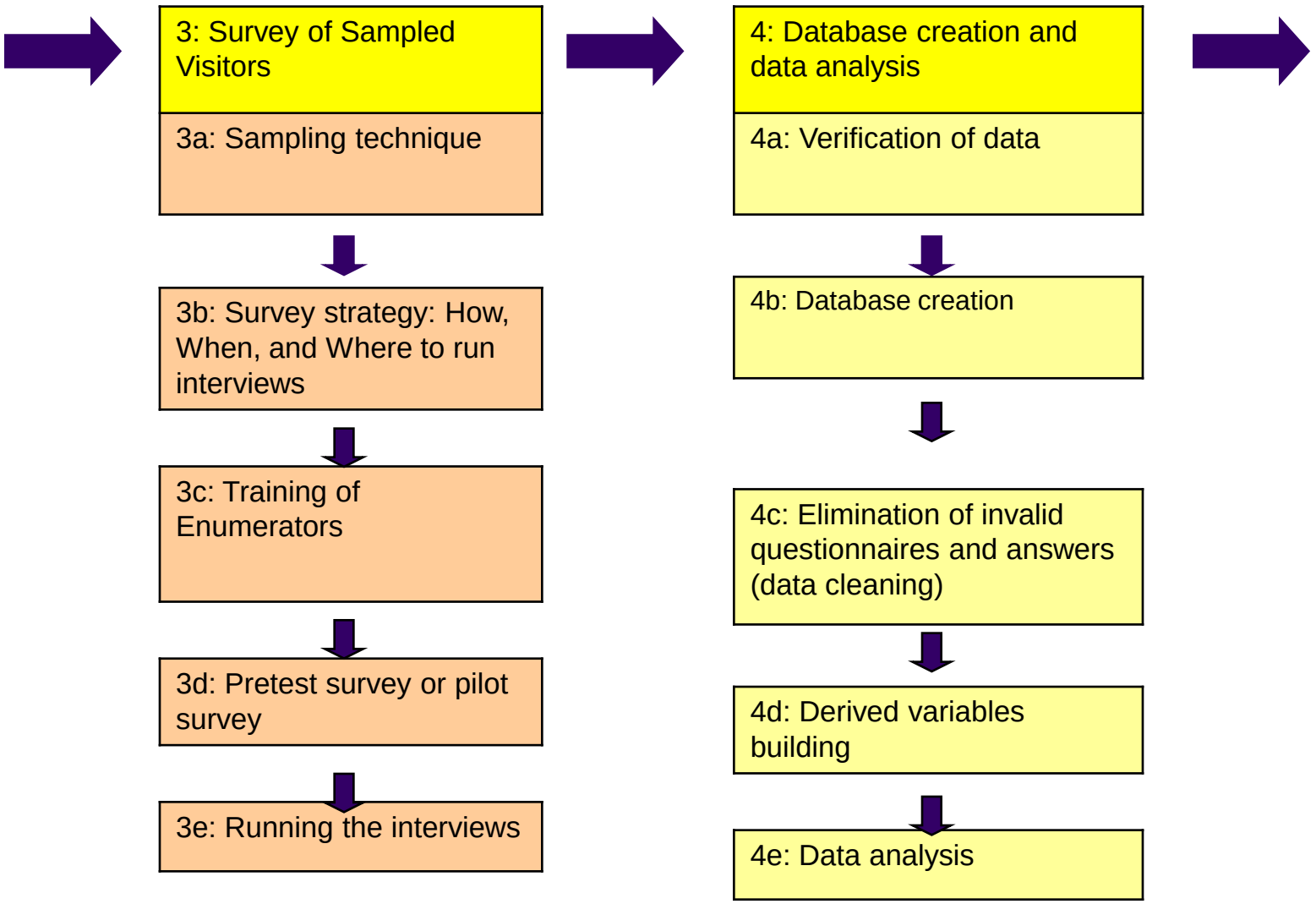
**2: Questionnaire Design**

2a: Introduction

2b: Socio-economic Information

2c: Questions on the dependent variable and explanatory variables

# Steps Involved……



# Steps Involved……

**5: WTP Estimation (Access Value)**

5a: Choice of ITCM equations (linear, log linear, double log, exponential)

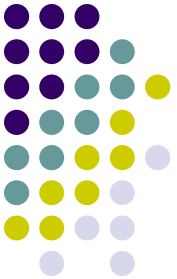
5b: Implement Models

5c: Annual individual Average WTP

5d: Annual net benefits

5e: Discounted value of annual benefits

# SAMPLING INTENSITY



**Representativeness of sampling frame covering various**

- **sub-populations of visitors**
- **period of survey**

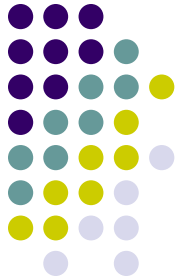
**This allows the use of 'large number' statistic tests such as t and F tests of significance.**

**Sampling intensity is dependent on sampling error considered appropriate.**

# Trip Cost

- Trip cost: sum of the expenses required to make a trip
- Typical costs for a day trip include:
  - Travel cost (round trip cost which include all transit expenses – fuel and upkeep, toll. Calculation: per-km cost*round-trip distance – RM/km)
  - Access fees (RM per person)
  - Equipment cost (vary by type of recreation. Can use rental fee. Often excluded because difficult to estimate)
  - Time cost (travel time and time spent on site, most difficult to estimate. Use wage rate – Calculation: wage rate/hr*time (hr). Use 1/3 of wage rate – lower bound. Upper bound use full wage rate)

# Estimate the Model: Some alternative and choice of functional forms



**Functional forms :**

- **Linear:** $V_i = a + b*TC_i + c*TC_{Si} + d*Y_i + e*Z_i$
- **Semi-log:** $\ln V = a + b*TC_i + c*TC_{Si} + d*Y_i + e*Z_i$
- **Double-log:** $\ln V = a + b*\ln TC_i + c*\ln TC_{Si} + d*\ln Y_i + e*\ln Z_i$

**Functional Selection**

- **A negative sign on the travel cost coefficient and appropriate signs for other coefficients**
- **A statistically significant t and F statistic at the 95% level of confidence**
- **An acceptable level of $R^2$ statistic**

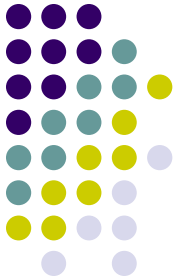
# Specify the Model

- Before data collection begins, consider variables in the right hand side

$V = f(TC_v, TC_s, Y, Z)$

- Every model include trip cost TC
- Other variables:
  - Trip cost to other sites
  - Income
  - Socio-economic variables
    - family size
    - Age
    - Gender
    - urban/rural residence
    - Occupation
    - level of education
    - club membership
    - equipment ownership
    - attitudinal information
    - experience in activity

# Some Empirical Issues



- Choice of dependent variable
- Multipurpose trips
- Holiday-makers vs. Residents
- Calculation of distance costs
- The value of time
- Statistical problems

# Empirical Analysis

- General model:

VISIT = f(TC,AGE,INCOME,EDUYR,GENDER,MARITAL)

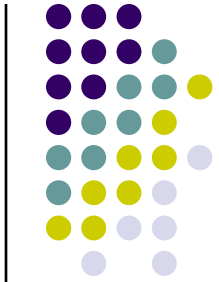
- Specific Model (Semi-log Model):

$$\mathrm{LnVISIT}_i = \alpha + \beta_1 \mathrm{TC}_i + \beta_2 \mathrm{AGE}_i + \beta_3 \mathrm{INCOME}_i + \beta_4 \mathrm{EDUYR}_i + \beta_5 \mathrm{GENDER}_i + \beta_6 \mathrm{MARITAL}_i + \varepsilon_i$$

- Estimated Model:

$$\widehat{\mathrm{LnVISIT}}_i = \hat{\alpha} + \hat{\beta}_1 \mathrm{TC}_i + \hat{\beta}_2 \mathrm{AGE}_i + \hat{\beta}_3 \mathrm{INCOME}_i + \hat{\beta}_4 \mathrm{EDUYR}_i + \hat{\beta}_5 \mathrm{GENDER}_i + \hat{\beta}_6 \mathrm{MARITAL}_i$$

# Consumer surplus estimation

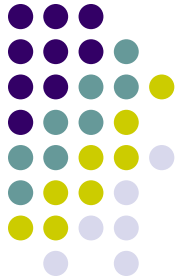


- Consumer surplus is estimated from the area under the demand curve
- This is by integrating the demand equation with respect to travel cost in the range between the choke travel price and the mean travel price for the whole sample
- The choke travel price is that cost above which there will be no trip undertaken by visitors, i.e. upper truncation of the travel cost axis
- The value of the integration measures the area below the demand curve in the range of the mean travel price to the choke travel price

# Computation of mean consumer's surplus per visitor

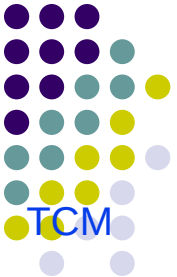
| Functional form | Equation | Mean consumer surplus/visitor |
|---|---|---|
| Linear | $V = \alpha + \beta_1 TC + \beta_2 X$ | $\left| (\alpha + \beta_1 \overline{X})TC + \frac{\beta_1}{2} TC^2 \right|_{TC}^{TC^*}$ |
| Semi-log | $LnV = \alpha + \beta_1 TC + \beta_2 X$ | $\left| \frac{1}{\beta_1} (e^{\beta_1 TC})(e^{\alpha + \beta_2 \overline{X}}) \right|_{TC}^{TC^*}$ |
| Double log | $LnV = \alpha + \beta_1 LnTC + \beta_2 LnX$ | $\left| (\frac{1}{\beta_1 + 1}) \overline{X}^{\beta_2} TC^{(\beta_1 + 1)} \right|_{TC}^{TC^*}$ |

Note:
TC* is the choke travel price, TC is the mean travel price and $\overline{X}$ is the mean of the vector of socio-economic variables
V is the number of visits per year
TC is travel price variable and X is the vector of socio-economic variables
$\alpha$, $\beta_1$, $\beta_2$ are the regression coefficients
*e* is the exponential sign taking the value of 2.718



# MULTIPLE SITE MODEL

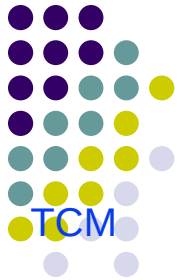
# Multiple Site Model or Random Utility Maximization (RUM) Model




## Introduction

- RUM considers a person's choice of a site for a recreation trip
- In choosing a site, a person is assumed to consider its "price" and its characteristics
- The "price" is the trip cost
- The characteristics – attributes/features of the site: ease of access, environmental quality, facilities
- Time frame – "choice occasion". E.g. when analyzing day trips, a choice occasion is simply a day

# Multiple Site Model



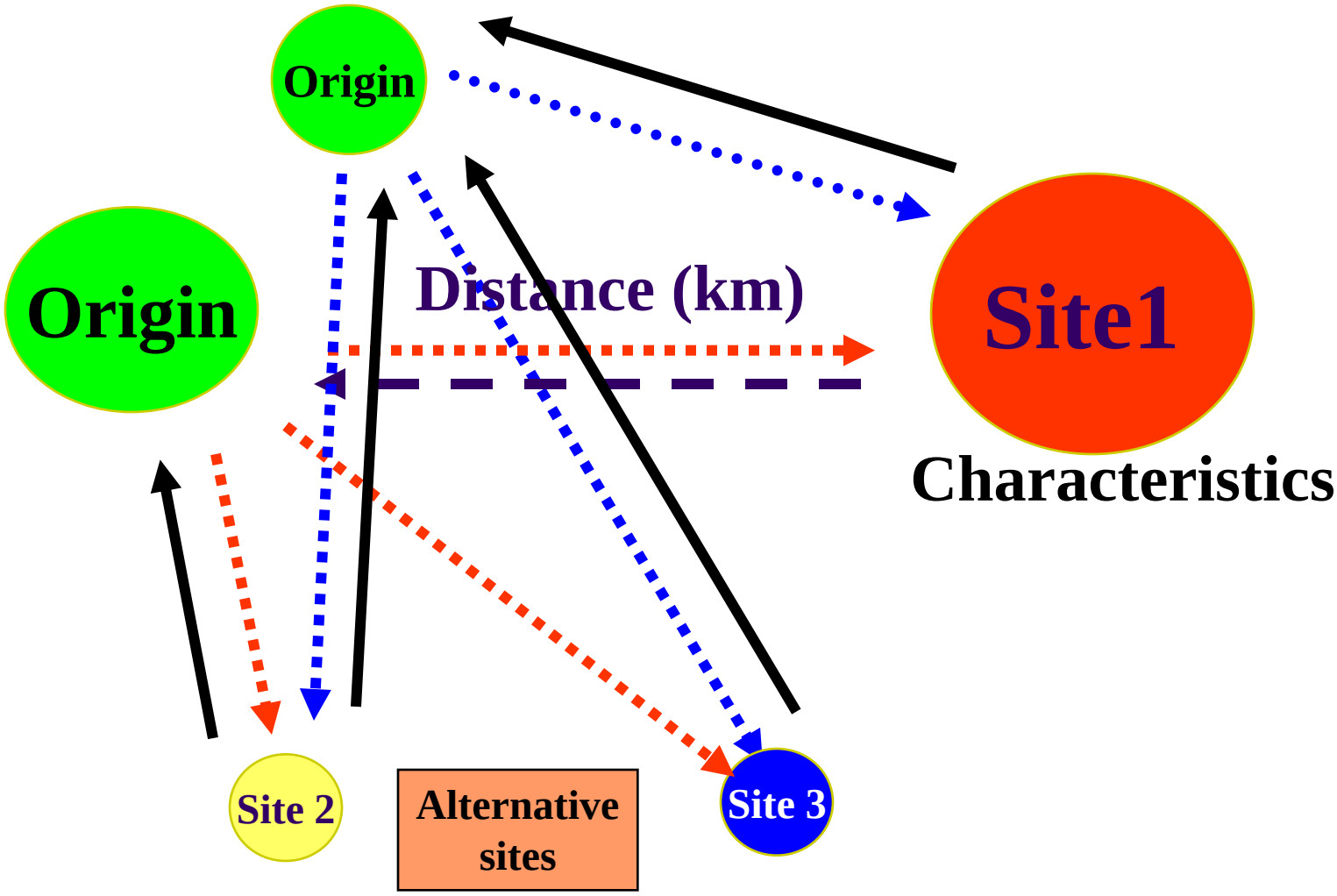

Basic Theory

- On a given choice occasion, a person considers visiting one of the sites, C as i=1,2,3,…C
- Each site – provide a person site utility $V_i$
- Utility, $V_i$ is a function of trip cost (tc) and site characteristics (q)
- Utility for site i, is given by:

$$V_i = \alpha + \beta_1 tc_i + \beta_2 q_i + \varepsilon_i$$

Tc is trip cost to the site I, q is a vector of site characteristics, $\varepsilon$ is random error, $\beta$ is parameter

# Multiple Site Model



# Multiple Site Model

- To value changes in site characteristics at one or more sites
- To value the access to more than one site simultaneously
- Use random utility maximization (RUM) model
- The method is also known as survey method
- Asking people about their choice of many recreation sites

# Multiple Site Model……RUM

- Individual I choice of one recreation site from a set of many possible sites on a single choice occasion in a season
- The choice set depends on characteristics of the area
- Trade off one site for another trip cost included as on characteristics

# Multiple Site Model……RUM

- Normally use in quality improvement. Some examples, include
- Improvement in water quality on lakes/rives
- Increase in catch rate of fish on lakes/rivers
- Improvement in condition of access to several urban/recreation parks
- Increase in wildlife population in several living areas
- Increase in the number of mountain hiking trails in a state park
- Improve access to one site or some sites simultaneously (e.g. to value the loss of several beaches closed because of development, to value several trails opened in the eco tourism development project)

# Data Set for Estimating a RUM Model (Three-site Choice Set)

| Observation | Number of Trips to Site | | | Trip Cost To Site (RM) | | | Water Quality Index at Site (1-10) | | | Monthly Income | Age |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Site 1 | Site 2 | Site 3 | Site 1 | Site 2 | Site 3 | Site 1 | Site 2 | Site 3 | (RM) | (yrs) |
| | (r1) | (r2) | (r3) | (tc1) | (tc2) | (tc3) | (q1) | (q2) | (q3) | | |
| 1 | 2 | 0 | 17 | 45 | 158 | 15 | 10 | 2 | 1 | 1700 | 35 |
| 2 | 1 | 0 | 3 | 111 | 201 | 35 | 8 | 7 | 5 | 2500 | 40 |
| 3 | 0 | 3 | 0 | 29 | 33 | 345 | 2 | 8 | 9 | 1000 | 28 |
| . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . |
| . | . | . | . | . | . | . | . | . | . | . | . |
| N | 12 | 0 | 0 | 12 | 66 | 123 | 5 | 2 | 1 | 1700 | 32 |

# Steps in Estimation - RUM

Step 1. Identify the impacts to be values
Step 2. Define the population of Users to be analyzed
Step 3. Define the choice set
Step 4. Develop a sampling strategy
Step 5. Specify the model
Step 6. Gather site characteristics
Step 7. Decide on the treatment of multiple purpose trips
Step 8. Design and implement the survey
Step 9. Measure trip cost
Step 10. Estimate model
Step 11. Calculate access and/or quality change values