MODULE- 1

Introduction

➢ Human Activities and environmental Pollution

1.Agriculture

- The environmental impact of irrigation includes the changes in quantity and quality of soil and water.
- Adverse effects of agriculture are soil erosion, contamination of water due to use of chemical fertilizers and pesticides, water logging etc.
- Discharge of nutrients into water bodies
- Discharge of pesticides into the environment
- Imposing burden on water resources.
- Deforestation
- Submergence of forest and other lands
- Evacuation and rehabilitation of people and villages
- Disturbance of wild life
- Mosquito breeding.
- Settled agriculture has increased food supply that lead to support more people, but decrease the environment quality.

2.Housing

- Use of large volume of materials for building industry and transportation of materials to construction sites causing high rate of consumption of natural resources.
- Extraction of constructional materials. Ex Sand, Boulders, Pebbles, Iron ore….ext.
- Cutting of forests
- Energy utilization
- Stress on water resources
- Urban centers impose heavy burden on the environment
- Disruption of storm water drainage patterns.

3. Energy Industry

- The environmental impact of energy harvesting and consumption is diverse.
- Thermal power plant consumes Coal, Natural gas etc… which may lead to global warming.
- In the real world of consumption of fossil fuel resources which lead to global warming and climate change.

- Stress On Water Resources
- Urban Centers Impose Heavy Burden On The Environment
- Disruption of Storm Water Drainage Patterns.
- Deforestation For Constructing Roads And Railways
- Air Pollution
- Noise Pollution
- Disruption Of Wildlife Habitats
- Pollution Of Marine Water Due To Harbors
- Pressure On Land And Other Natural Resources For Raw Material.
- Pressure On Transport System.

4.Mining- The environmental impact of mining includes

- Deforestation
- Large tracts of land are made barren.
- Soil erosion
- The transportation of ores impose heavy burden on transport facilities.
- Noise pollution
- The environmental impact of mining includes formation of sinkholes, loss of biodiversity, and contamination of soil, groundwater and surface water by chemicals from mining processes.
- In some cases, additional forest logging is done in the vicinity of mines to increase the available room for the storage of the created debris and soil. Besides creating environmental damage, contamination resulting from leakage of chemicals also affect the health of the local population.
- Mining companies in some countries are required to follow environmental and rehabilitation codes, ensuring the area mined is returned to close to its original state. Some mining methods may have significant environmental and public health effects.

5. Transportation activities-

- The environmental impact of transport is significant because it is a major user of energy, and burns most of the world's petroleum.
- This creates air pollution, including release of nitrous oxides and particulates, and is a significant contributor to global warming through emission of carbon dioxide, for which transport is the fastest-growing emission sector. By subsector, road transport is the largest contributor to global warming.
- Adverse effects on environment- air pollution, consumption of natural resources like petrol, diesel at faster rate

6. War

- As well as the cost to human life and society, there is a significant environmental impact of war. Scorched earth methods during, or after war it has been in use for much of recorded history but with modern technology war can cause a far greater devastation on the environment.
- Usage of Nuclear weapons, which lead to increases radioactive components into the environment.

7. Manufactured products

- The environmental impact of cleaning agents is diverse. In recent years, measures have been taken to reduce these effects.

Paint- The environmental impact of paint is diverse. Traditional painting materials and processes can have harmful effects on the environment, including those from the use of lead and other additives. These include usage of solvents, dispersing agents, dies etc. Which intern results in the release of volatile organic compounds such as methylene chloride, ethylene chloride, benzene etc…

Paper- The environmental impact of paper is significant, which has led to changes in industry and behavior at both business and personal levels. With the use of modern technology such as the printing press and the highly mechanized harvesting of wood, paper has become a cheap commodity.

Pesticides- The environmental impact of pesticides is often greater than what is intended by those who use them. Over 98% of sprayed insecticides and 95% of herbicides reach a destination other than their target species, including non target species, air, water, bottom sediments, and food. Pesticide contaminates land and water when it escapes from production sites and storage tanks, when it runs off from fields, when it is discarded, when it is sprayed aerially, and when it is sprayed into water to kill algae.

8. Water resource projects – which includes construction of Dams, Irrigation canals, channels, weirs, etc

- Imposing burden on water resources.
- Deforestation
- Submergence of forest and other lands
- Water logging problems
- Evacuation and rehabilitation of people and villages
- Disturbance of wild life

Need for protected water supply.

- Protected water supply means the supply of water that is treated to remove the impurities and made safe to public health. Water may be polluted by physical and bacterial agents.
- The protected water supply system is only available in urban areas and only to some extent in rural areas. But the country like India is essentially a village based country and majority of population which lives in rural villages need safe and portable water for usage.
- Most of the rural population if not provided with protected water supply systems. They are mostly depending upon the conventional sources like wells, ponds and streams etc are generally in polluted condition.
- People consuming this water without any treatment they are bound to suffer from water borne diseases like typhoid, dysentery, cholera, poliomyelitis, Jaundice, gunia worm etc.

- The rural water supply system aim to provide reasonable quantity of safe wholesome water to satisfy demands of people and thus helping in maintaining better sanitation and beautification of surroundings, thereby reducing environmental pollution.

<u>The Per Capita Demand</u> <u>(q)</u>

It is the annual average amount of daily water required by one person, and includes the domestic use, industrial and commercial use, public use, waster etc. It may, therefore, be expressed as

Per Capita Demand (q) in litres per day per head

$$= \frac{\text{total yearly water requirements of the city in liters (i.e. V)}}{\text{365 X Design population}}$$

Total yearly water requirement of the city can, therefore, be worked out by using above equation, provided the per capita demand is known or assumed.

For an average Indian town, the requirement of water in various uses is as under

i.	Domestic purpose	135 litres/c/d
ii.	Industrial use	40 litres/c/d
iii	Public use	25 litres/c/d
iv.	Fire Demand	15 litres/c/d
v.	Losses, Wastage and thefts	55 litres/c/d

Total : 270 litres/capita/day

<u>Factors affecting Per Capita Demand</u>

(1) Size of the city. The per capita demand for big cities is generally large as compared to that for smaller towns. This is because of the fact that in big cities, huge quantities of water are required for maintain clean and healthy environments. For example, big cities are generally sewered, and as such require large quantities of water (a sewered house requires four to five times the water required by an unsewered home). Similarly, in a big city, commercial and industrial activities are generally more, thus requiring more water. Affluent rich living in air cooled homes may also increase the water consumption in cities.

(2) Climatic Conditions. As hotter and dry places, the consumption of water is generally more, because more of bathing, cleaning, air cooling, sprinkling in lawns, gardens, roofs, etc., are involved. Similarly, in extremely cold countries more water may be consumed, because the people may keep their taps open to avoid freezing of pipes, and there may be more leakage from pipe joints, since metals contract with cold.

(3)Types of luxury used and Habits of people. Rich and upper class communities generally consume more water due to their affluent living standards. Middle class communities consume average amounts.

(4) Industrial and Commercial Activities. The pressure of industrial and commercial activities at a particular place increases the water consumption by large amounts. Many industries require really huge amounts of water (much more than the domestic demand), and as such, increase the water demand considerably.

(5) Quality of Water Supplies. If the quality and taste of the supplied water is good, it will be consumed more, because in that case, people will not use other sources such as private wells, hand pumps, etc. Similarly, certain industries such as boiler feeds, etc., which require standard quality waters will not develop their own supplies and will use public supplies, provided the supplied water is up to their required standards.

(6) Pressure in the Distribution System. If the pressure in the distribution pipes is high and sufficient to make the water reach at 3rd or even 4th storey, water consumption shall definitely be more.

(7) Development of Sewerage Facilities. As pointed out earlier, the water consumption will be more, if the city is provided with 'flush system' and shall be less if the old 'conservation system' of latrines is adopted.

(8) System of Supply. The water may be supplied either continuously for all the 24 hours of the day, or may be supplied only of peak periods during the morning and evening. The second system, i.e, the intermittent supplies, may lead to some saving in water consumption due to losses occurring for lesser time and a more vigilant use of water by the consumers.

(9) Cost of Water. If the water rates are high, lesser quantity many be consumed by the people. This may not lead to large savings as the affluent and rich people are little affected by such policies.

(10) Policy of Metering and Method of Charging. Water tax is generally charged in tow different ways:

(a) On the basis of meter reading (meters fitted at the head of the individual house connections and recording the volume of water consumed).

(b) On the basis of certain fixed monthly flat rate.

VARIATIONS IN DEMAND. (q)

The per capita demand (q), so far discussed, has been based upon the annual consumption of water. It was, therefore, defined as the **annual average daily consumption** per person.

There are wide variations in the use of water in different seasons, in different months of the year, in different days of the month, in different hours of the day, and even in different minutes of the hour.

1) **Seasonal variations.** The water demand varies from season to season. Occur due to larger use of water in summer season, lesser use in winter, and much less in rainy season. These variations may also be caused by season use of water in industries such as processing of cash crops at the time of harvesting, etc.
   - **Maximum seasonal consumption= 1.3 times of annual average daily rate of Demand**

2) **Daily variation.** Day to day variation is called **daily variation.** This variation depends on the general habits of people, climatic conditions and character of city as industrial, commercial or residential. For example, the water consumption is generally more on Sundays and holidays, on days of dust storms, etc.

- **Maximum Daily consumption= 1.8 times the average demand**

3) **Hourly variation.** Again there are variations in hour to hour demand called hourly variations. For example, the consumption in the early hours of morning (0 to 6 hours-say) is generally small, increases sharply as the day advances, reaching a peak value between about 8 to 11 AM, then decreases sharply upto about 1 PM, remains constant upto about 4 PM, again increases in the evening reaching a peak between 7 to 9 PM, finally falling to a low value in the late hours of night, as shown if Fig.

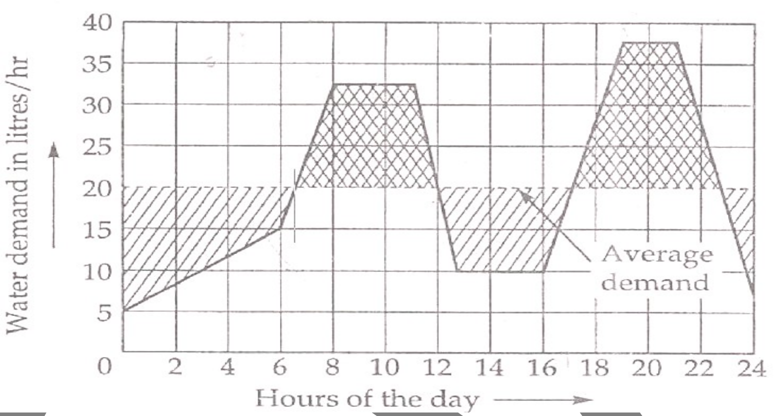

Fig : Showing hourly rate of water consumption.

- **Maximum hourly consumption= 1.5 times the average demand**

The determination of this hourly variations is most necessary, because on its basis the rate of pumping will be adjusted to meet up the demand in all hours.

PEAK FACTOR

- Maximum hourly consumption of the maximum day is called **Peak demand.** Which is nothing but a factor of safety.

The GOI manual on water supply has recommended the following values of the **Peak factor,** depending upon the population:

Table : Peak Factors

S. No.	Population	Peak factor*
Up td. 5	i) upto 50,000 ii)50,001-2,00,000 iii)Above 2 lakhs	3.0 2.5 2.0
2.	For Rural water supply schemes, where supply is effected through stand post for only 6 hours.	3.0
2.		

- Evidently, the peak factor tends to reduce with increasing population, since the different habits and customs of several groups in larger population, tend to minimize the variation in demand pattern.

DESIGN PERIODS

Water supply projects are designed to serve over a specified period of time after completion of the project. This time period is called **Design period.**

OR

A water supply scheme includes huge and costly structures (such as dams, reservoirs, treatment works, penstock pipes, etc.) which cannot be replaced or increased in their capacities, easily and conveniently. For example, the water mains including the distributing pipes are laid underground, and cannot be replaced or added easily, Without digging the roads or disrupting the traffic In order to avoid these future complications of expansions, the various components of water supply scheme are purposely made larger, so as to satisfy the community needs for the reasonable number of years to come. This future period or the number of years for which a provision is made in designing the capacities of the various components of the water supply scheme is known as **Design period.**

Factors Governing the Design Period

1. Useful life of the pipes, structures and equipment used in the water works and the chances of their becoming old and absolute. The design period should not exceed those respective values . If the useful life is more, design period is also more.
2. The anticipated rate of growth of population. If the rate is more, design period is less.
3. The rate of interest of loans taken for the construction of the project. If this rate is more the design period will be less.
4. The rate of inflation during the period of repayment of loans. When the inflation rate is high, a longer design period is adopted.
5. Efficiency of component units of the project during the early years of working, when they are not loaded to their capacity. The more the efficiency, the longer the design period.

Demand of Water

Before designing a proper water works project, it is essential to determine the quantity of water that is required daily.

Types of water demand:-

(i) Domestic water demand
(ii) Industrial water demand
(iii) Institution and commercial water demand
(iv) Demand for public use
(v) Fire demand

(1)Domestic water demand

This includes the water required in residential buildings for drinking, cooking, bathing, lawn sprinkling, gardening, sanitary purposes etc. The amount of domestic water consumption per person shall vary according to the living conditions of the consumers. As per IS 1172-1993, the minimum domestic consumption for a town or a city with full flushing system should be taken at 200l/h/d .

Table 1: Minimum domestic water consumption for Indian towns and cities with full flushing systems as per IS 1172-1993.

Use	Consumption in liters per head per day(l/h/d)
Drinking	5
Cooking	5
Bathing	55
Washing of clothes	20
Washing of utensil	10
Washing and cleaning of ho	10
Flushing of water closets etc.,	30
TOTAL	135

(2) Industrial water demand.

Industrial require a large volume of water for manufacturing processes, cooling operation, steam generation, for processing and sanitation purposes etc, this part of water in known as 'industrial demand'.

In industrial cities, the per capita water requirement may finally be computed to be as high as 450 liter/person/day or so, as compared to the normal industrial requirement of 50 liters/person/day.

(3) Institutional and commercial water demand.

On an average, a per capita demand of 20 liters/head /day is usually considered to be enough to

POPULATION FORECASTING

The various methods which are generally adopted for estimating future populations by engineers are described below. Some of these methods are used when the design period is small, and some are used when the design period is large. The particular method to be adopted for a particular case or for a particular city depends largely upon the factors discussed in these methods, and the selection is left to the discretion and intelligence of the designer.

1) Arithmetical Increase Method

This is the most simple method of population forecast, though it generally gives lower results. In his method, the increase in population from decade to decade is assumed constant. Mathematically, this hypothesis may be expressed as,

$$dp/dt = K$$

Where *dp/dt* is the rate of change of population and K is a constant. From the census data of past 3 or 4 decades, the increase in population for each decade is found, and from that an average increment is found. For each successive future decade, this average increment is added. The future population P_n after n decades is thus given by,

$$P_n = P_0 + nx$$

Where P_n = future population after n decades

P_0 = present population

x = average increment for a decade.

- ❖ This method should be used for forecasting population of those large cities, which have reached their saturation population.

2) Geometrical increase method.

This method is based on the assumption that the ***percentage increase*** in population from decade to decade remains constant. In this method the average percentage of growth of last few decades is determined, the population forecasting is done on the basis that percentage increase per decade will be the same. This method is also therefore known as ***uniform increase method.***

The population at the end of 'n' decades is calculated by

$$P_n = P_0 \left[1 + \frac{r}{100}\right]^n$$

Where P_0 = Initial population; i.e the population at the end of last known census.

P_n = Future population after **n** decades.

r = Growth rate (%)

This growth rate (r) can be computed in several ways from the past known population data. one method is to compute r, as

$$r = \sqrt{(P_2/P_1} - 1$$

Where P_1 = Initial known population
P_2 = Final known population
t = Number of decades between P_1 and P_2.

(or)

The average may again be either the **arithmetic average**. i.e

$$r = \frac{r_1+r_2+r_3+r_4\ldots+r_t}{t}$$

OR

geometrical average i.e. $r = \sqrt{r_1 r_2 r_3 r_4 \ldots . r_t}$

3) Method of Varying Increment *or* Incremental Increase Method.

The method combines both the arithmetic average method and the geometrical average method. From the census data for the past several decades, the actual increase in each decade is first found. Then the increment in increase in each decade is first found. From these, an average increment of the increases (known as incremental increase) is found. The population in the next decade is found by adding to the present population the average increase plus the average incremental increase per decade. The process repeated for the second future decade, and so on. Thus the future population at the end of n decades is given by:

$$P_n = P_0 + nx + \frac{n(n+1)}{2} y$$

Where P_0 = present population
x = average increase per decade
y = average incremental increase
n = number of decades.

4) Decreasing Rate of Growth Method. Since the rate of increase in population goes on reducing, as the cities reach towards saturation, a method which makes use of the decrease in the percentage increase, is many a times used, and gives quite rational results. In this method, the average decrease in the percentage increase for each successive decade. This method is however, applicable only in cases, where the rate of growth shows a downward trend.

5) Simple Graphical method. In the method, a curve is drawn between the population P and time T, with the help of census data of previous few decades, So that the shape of the population curve is obtained – up to the present period. The curve is then carefully is then carefully extended from the present to the future decades. From the extended part of the curve, the population at the end of any future decade is approximately determined.

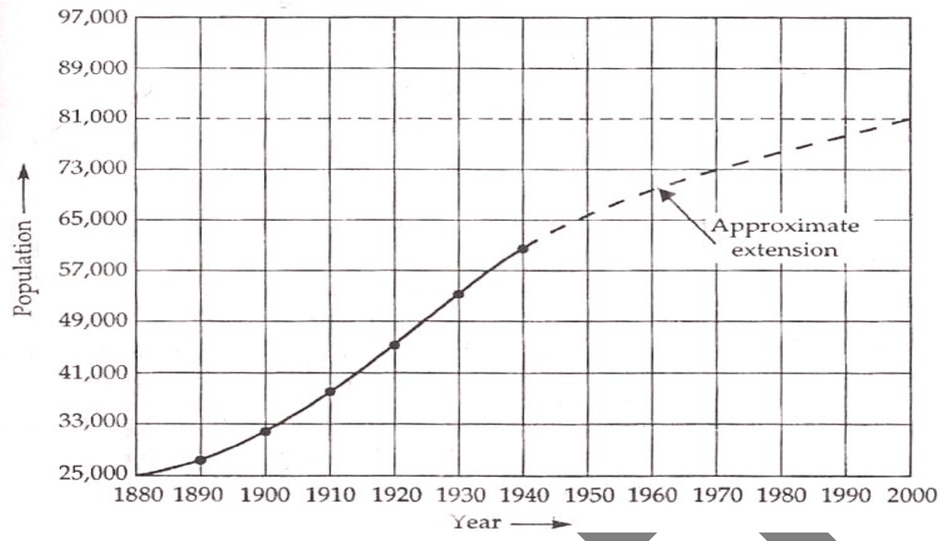

Fig: Graph between population and time

6) Comparative Graphical Method.

This method is a variation of the previous method. It assumes that the city under consideration will develop as similar cities developed in the past. The method consists of plotting curves of cities that, one or more decades ago, had reached the present population of the city under consideration.

Thus, as shown in Fig, the population of city A under consideration is plotted upto 1970 at which its population is 62,000. The city B having similar conditions, reached the population of 62,000 in 1930 and its curve is plotted from 1930 onwards. Similar curves are plotted for other cities C, D and E which reached the population of 62000 in 1925, 1935 and 1920 respectively. The curve of city A can be then be continued (shown by dotted line), allowing it to be influenced by the rate of growth of the larger cities. In practice however, is difficult to find identical cities with respect to population growth.

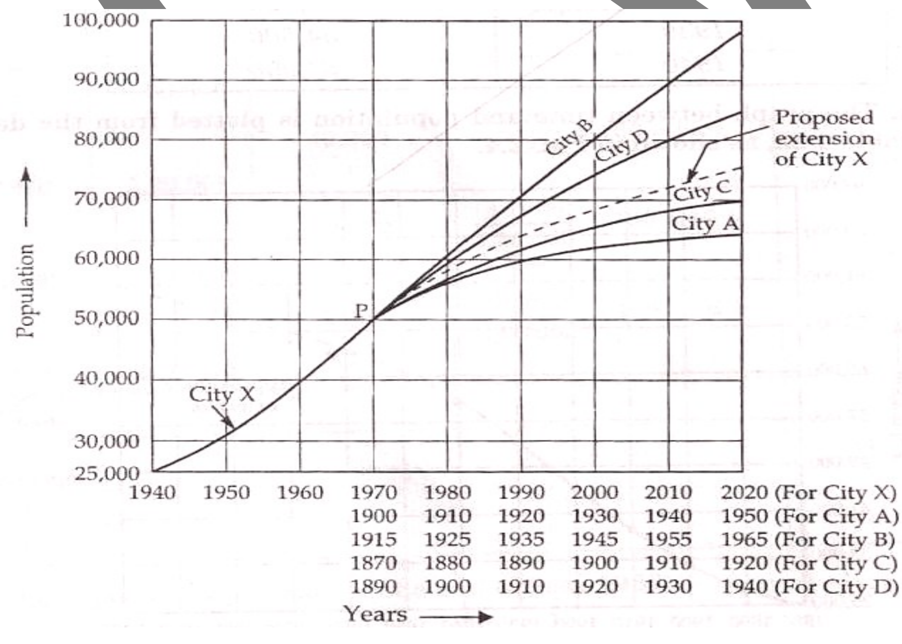

Fig: Comparative Graphical Method

7) Zoning Method or Master Plan Method.

This is probably a scientific method using the limitations imposed by the town planner in the increase in density of population of various parts of the city. For this, a master plan of the city is prepared, dividing it into various zones such as industrial, commercial, residential and other zones. Each zone is allowed to develop as per master plan only. The future population of each zone, when fully developed can be easily found. For example, sector A of a residential zone has 1000 plots. Allowing 5 persons per plot, the population of this sector, when fully developed, will be 1000 X 5= 5000 persons. Similarly, the development of each zone can be estimated. This method is more advantageous because of the fact that the total water requirement of the city depends not only of domestic purposes, but also for commercial, industrial, social health and other purposes.

8. <u>Ratio and Correlation method</u>

The population growth of a small town or area is related to big towns or big areas. The increase in population of big cities bears a direct relationship to the whole state or country. In this method, the local to national (or state) population ratio is determined in the previous two to four decades. Depending upon condition or other factors, even changing ration may be adopted. These ratios may be used in predicting their future population. This method takes into account the regional and national factors affecting population growth. This method is useful for only those areas whose population growth in past is fairly consistent with that of state or nation.

9. <u>Growth Composition Analysis Method</u>

The change in population of a city is due to three reasons: (i) birth, (ii) death, and (iii) migration from villages or other towns. The population forecast may be made by proper analysis of these three factors. The difference between birth rate and death rate gives the natural increase in the population . Thus,

$$P_n = P + \text{Natural increase} + \text{Migration.}$$

The estimated increase is given by the following expression:

$$\text{Natural increase} = T(I_B P - I_D P)$$

Where T= design (forecast) period

P= present population.

I_B = average birth rate per year.

I_D = average death rate per year.

10) <u>The logistic curve method.</u> It is explained earlier that under normal conditions, the population of a city shall grow as per the ***logistic curve.*** **Verhulst** has put forward a mathematical solution for this mathematical solution for this logistic curve. According to him, the entire curve can be represented by an autocatalytic first order equation, given by,

$$\log_e\left(\frac{P_s - P}{P}\right) - \log_e\left(\frac{P_s - P_0}{P_0}\right) = -K P_s . t \qquad ...(2.20)$$

where P_0 = The population at the start pt. of the curve A.

P_s = Saturation population.

P = Population at any time t from the origin A.

K = Constant.

From Eq. (2.20), we get

$$\log_e\left[\left(\frac{P_s - P}{P}\right) \times \left(\frac{P_0}{P_s - P_0}\right)\right] = -K P_s t$$

or

$$\left(\frac{P_s - P}{P}\right)\left(\frac{P_0}{P_s - P_0}\right) = \log_e^{-1}(-K.P_s.t.)$$

or

$$\frac{P_s - P}{P} = \left[\frac{P_s - P_0}{P_0}\right]\log_e^{-1}(-K.P_s.t)$$

or

$$\frac{P_s}{P} - 1 = \left[\frac{P_s - P_0}{P_0}\right]\log^{-1}(-K.P_s.t.)$$

or

$$\frac{P_s}{P} = 1 + \left[\frac{P_s - P_0}{P_0}\right]\log_e^{-1}(-K.P_s.t.)$$

or

$$P = \frac{P_s}{1 + \frac{P_s - P_0}{P_0}\log_e^{-1}(-KP_s.t.)} \qquad ...(2.21)$$

Substituting $\frac{P_s - P_0}{P_0} = m$ (a constant)

and $\qquad -K.P_s = n$ (another constant)

we get

$$\boxed{P = \frac{P_s}{1 + m.\log_e^{-1}(nt)}} \qquad ...(2.22)$$

This is the required equation of the logistic curve. McLean further suggested that if only three pairs of characteristic values P_0, P_1, P_2 at times $t = t_0 = 0, t_1$, and $t_2 = 2t_1$ extending over the useful range of the census populations, are chosen, the saturation value P_s and the constants m and n can be evaluated from three simultaneous equations, as follows :

$$P_s = \frac{2P_0P_1P_2 - P_1^2 (P_0 + P_2)}{P_0P_2 - P_1^2} \quad ...(2.23)$$

$$m = \frac{P_s - P_0}{P_0} \quad ...(2.24)$$

$$n = \left(\frac{1}{t_1}\right) \log_e \left[\frac{P_0(P_s - P_1)}{P_1(P_s - P_0)}\right] \quad ...(2.25)$$

$$= \frac{2.3}{t_1} \log_{10} \left[\frac{P_0(P_s - P_1)}{P_1(P_s - P_0)}\right] \quad ....(2.25a)$$

Knowing P_0, P_1 and P_2 from census data and using them in these equations, the values of P_s, m and n are known, and the equation of the logistic curve (Eq. 2.22) is thus known. From that, the population P at any time t can then be obtained, as explained in the example given below.