

GE 2211 Environmental Science and Engineering

Unit – I

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Food Resources

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- food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies

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Total Population

World / Region	Total population (million)						
	1990	2000	2010	2020	2030	2040	2050
WORLD	5 280	6 086	6 843	7 578	8 199	8 701	9 076
Developed countries	1 256	1 316	1 355	1 385	1 396	1 396	1 386
Developing countries	4 023	4 769	5 485	6 193	6 803	7 306	7 690

Per Person Food Availability

World/Region	1969-1971	1979-1981	1989-1991	2000-2002
 (kcal/day)			
WORLD	2 410	2 550	2 700	2 790
Developed countries	3 140	3 220	3 290	3 280
Developing countries	2 110	2 310	2 520	2 660

World Fertilizer Production and Consumption

Fertilizer	Production			Consumption		
	1980/1981	1990/1991	2002/03	1980/1981	1990/1991	2002/03
(million tonnes)						
Nitrogen	63	82	88	61	77	85
Phosphate	35	39	34	32	36	34
Potash	27	27	26	24	25	23
Total	125	148	148	117	138	142

Producers	Production	% of World	Consumers	Consumption	% of World
	(million tonnes)	production		(million tonnes)	consumption
2002/2003			2002/2003		
China	32	22	China	40	28
United States of America	18	12	United States of America	19	13
India	14	9	India	16	11
Russian Federation	13	8	Brazil	8	6
Canada	12	8	France	4	3
Rest of the World	59	41	Rest of the World	55	39

Source: FAO

Food and Agriculture Organization of the United Nations

Pesticide Production in the World

1990	1995	2000
(thousand tonnes)		
2 318	2 045	2 254

Source: FAO

World Food Problems

- In 1996, the World Bank estimated that more than one billion of the world's people do not have enough food to lead healthy and productive lives
- Based on assessments by Population Action International (1997), more than three billion people, or half of humanity, subsist on less than \$2 a day, and both the number of people and the proportion of total population living in such extreme poverty are rising
- According to the Food and Agriculture Organization (FAO, 1997), 840 million of the world's 1.1 billion poor live in rural areas, where 15 million die each year from starvation and related diseases.
- About 80 countries do not produce enough food to feed their populations.

Causes of Food Problems

- *Poverty and rapid population growth* are positively correlated. Where per capita income increases, population growth rates decline and vice versa. In other words, the higher the incidence of poverty, the higher is the population growth
- Scarcity of agricultural land is not the primary cause of food shortages, although it too exacerbates the problem.

Technology in Food Production

- It is often assumed that world food shortages can be eliminated by increasing food and agricultural production through the application of modern technology
- It is also argued that supplying modern inputs—such as large-scale irrigation, chemical fertilizers, farm machinery, and pesticides—can improve the productive capacity of the land
- However, when a new agricultural technology enters a system characterized by unequal power relationships, it brings greater profits only to those who already have some combination of land, financial resources, creditworthiness, and political influence

Farm Size and Credit Services

- The disparities in the availability of institutional support systems in the distribution of services between large and small farmers work to the disadvantage of the latter
- Since large farmers are conventionally considered to be more productive than small farmers, the large landholders are provided with public subsidies and credit facilities
- The small farm operators are usually disqualified from farm credit loans because of their disadvantaged economic condition
- Small farmers are often excluded from the modern marketing process, and have high input costs relative to large farmers because they lack bargaining power and do not buy farm inputs in bulk

Food insecurity in India

(report by World Food Programme and
MSSwaminathan Research Foundation, 2009)

- The report says that the number of undernourished people is rising, reversing gains made in the 1990s.
- Slowing growth in food production, rising unemployment and declining purchasing power of the poor in India are combining to weaken the rural economy.
- Food security has three components: availability of food in the market, access to food through adequate purchasing power, and absorption of food in the body.

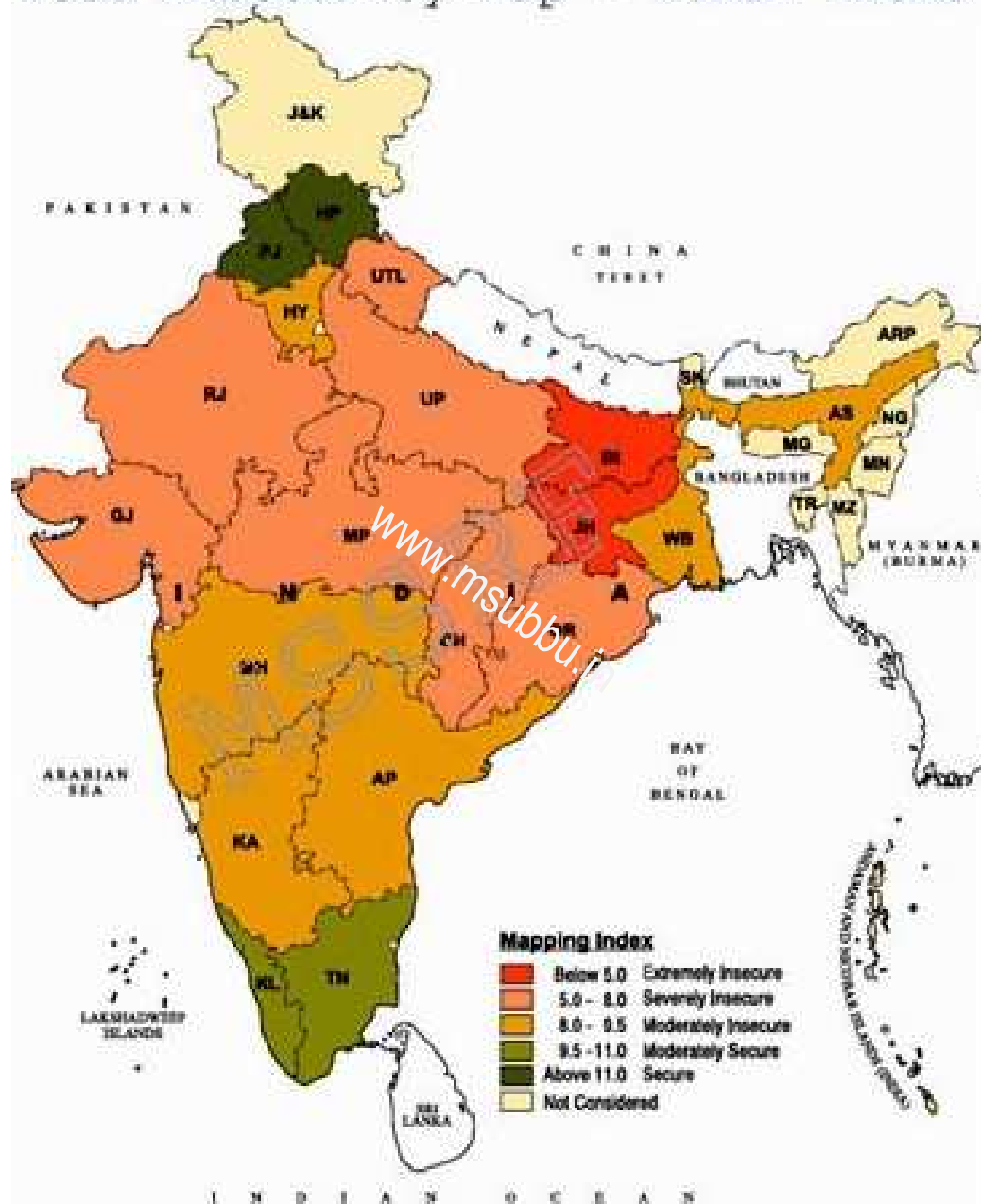
Food insecurity in India (contd.)

- At the global level, the South Asian region is home to more chronically food insecure people than any other region in the world and India ranks 94th in the Global Hunger Index of 119 countries.
- While famines and starvation deaths remain the popular representation of the contemporary problem of hunger, one of the most significant yet understated and perhaps less visible area of concern today is that of chronic or persistent food and nutrition insecurity.
- On the composite index of food insecurity of rural India, states like Jharkhand and Chhattisgarh are found in the 'very high' level of food insecurity, followed by Madhya Pradesh, Bihar and Gujarat.
- The better performers include Himachal Pradesh, Kerala, Punjab and Jammu and Kashmir.

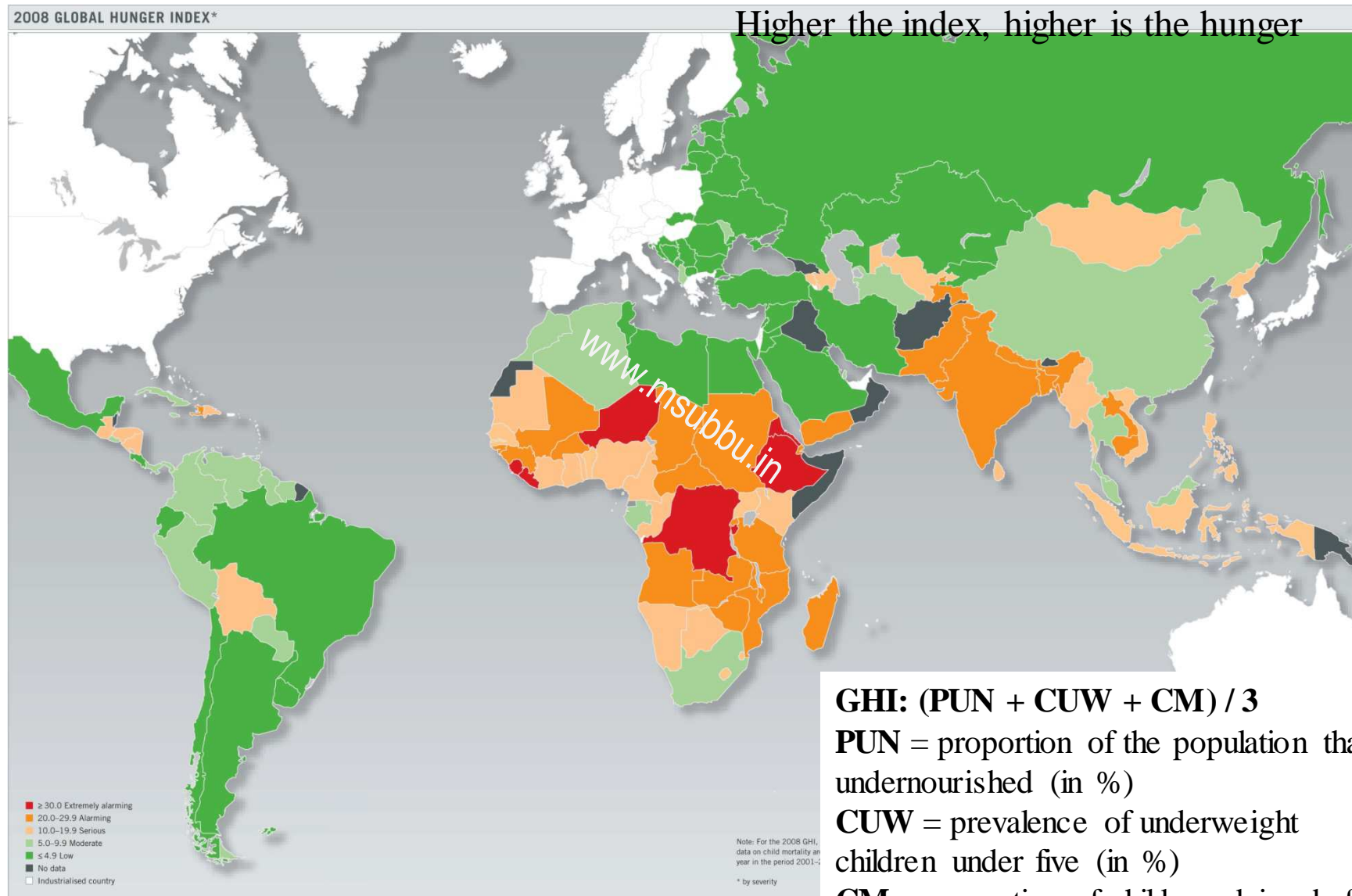
Food insecurity in India (contd.)

- Even economically developed states like Gujarat, Maharashtra, Andhra Pradesh and Karnataka find themselves in the category of high food insecurity - a reflection perhaps of the manifestation of the agrarian crisis in the states and its consequent negative impact on the health and well-being of the rural population.

Food Insecurity Map - Rural India



Global Hunger Index



GHI: (PUN + CUW + CM) / 3

PUN = proportion of the population that is undernourished (in %)

CUW = prevalence of underweight children under five (in %)

CM = proportion of children dying before the age of five (in %)

Causes of Food Problems

Worldwide Problems

- Natural catastrophes - drought, heavy rain and flooding, crop failures.
- Environmental degradation - soil erosion and inadequate water resources.
- Food supply-and-demand imbalances.
- Inadequate food reserves.
- Warfare and civil disturbances.
- Migration -refugees
- Culturally-based food prejudices.
- Declining ecological conditions in agricultural regions

Causes of Food Problems (contd.)

Problems of the Developing World

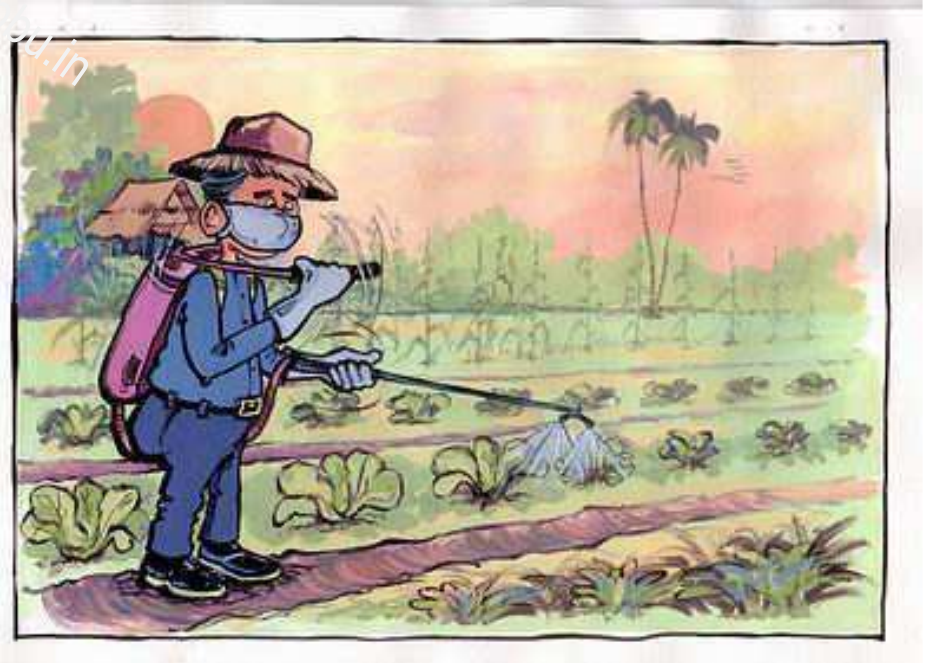
- Underdevelopment.
- Excessive population growth.
- Lack of economic incentives - farmers using inappropriate methods and laboring on land - they may lose or can never hope to own.
- Parents lacking knowledge of basic nutrition for their children.
- Insufficient government attention to the rural sector.

Causes of Food Problems (contd.)

Problems of the Industrialized World

- Excessive use of natural resources.
- Pollution.
- Inefficient, animal-protein diets.
- Inadequate research in science and technology.
- Excessive government bureaucracy.
- Loss of farmland to competing uses.

Agriculture



Traditional Agriculture

- Until about four decades ago, crop yields in agricultural systems depended on internal resources, recycling of organic matter, built-in biological control mechanisms and rainfall patterns
- Agricultural yields were modest, but stable. Production was safeguarded by growing more than one crop or variety in space and time in a field as insurance against pest outbreaks or severe weather.
- Inputs of nitrogen were gained by rotating major field crops with legumes. In turn rotations suppressed insects, weeds and diseases by effectively breaking the life cycles of these pests
- Most of the labor was done by the family with occasional hired help and no specialized equipment or services were purchased from off-farm sources.
- In these type of farming systems the link between agriculture and ecology was quite strong and signs of environmental degradation were seldom evident

Modern Agriculture

- As agricultural modernization progressed, the ecology-farming linkage was often broken as ecological principles were ignored and/or overridden
- Evidence has accumulated showing that whereas the present capital- and technology-intensive farming systems have been extremely productive and competitive, they also bring a variety of economic, environmental and social problems
- Evidence also shows that the very nature of the agricultural structure and prevailing policies have led to this environmental crisis by favoring large farm size, specialized production, crop monocultures and mechanization.
- Lack of rotations and diversification take away key self-regulating mechanisms, turning monocultures into highly vulnerable agroecosystems dependent on high chemical inputs.

Problems due to Fertilizer usage

- Fertilizers have been praised as being highly associated with the temporary increase in food production observed in many countries
- But the bountiful harvests created at least in part through the use of chemical fertilizers, have associated, and often hidden, costs. A primary reason why chemical fertilizers pollute the environment is due to wasteful application and the fact that crops use them inefficiently.
- The fertilizer that is not recovered by the crop ends up in the environment, mostly in surface water or in ground water.
- Nitrate contamination of aquifers is widespread and in dangerously high levels in many rural regions of the world.
- In the US, it is estimated that more than 25% of the drinking water wells contain nitrate levels above the 45 ppm safety standard. Such nitrate levels are hazardous to human health and studies have linked nitrate uptake to methaemoglobinemia in children and to gastric, bladder and oesophageal cancers in adults

Problems due to Fertilizer usage (contd.)

- Fertilizer nutrients that enter surface waters (rivers, lakes, bays, etc.) can promote eutrophication, characterized initially by a population explosion of photosynthetic algae.
- Algal blooms turn the water bright green, prevent light from penetrating beneath surface layers, and therefore killing plants living on the bottom. Such dead vegetation serve as food for other aquatic microorganisms which soon deplete water of its oxygen, inhibiting the decomposition of organic residues, which accumulate on the bottom.
- Eventually, such nutrient enrichment of freshwater ecosystems leads to the destruction of all animal life in the water systems. In the US it is estimated that about 50-70% of all nutrients that reach surface waters is derived from fertilizers.

Problems Associated with Pesticides

- harmful side effects on non-target organisms (people, animals, soil, water, etc.)
- revival of pest populations (because natural control is disrupted)
- the development of resistance
- the cost

Overgrazing

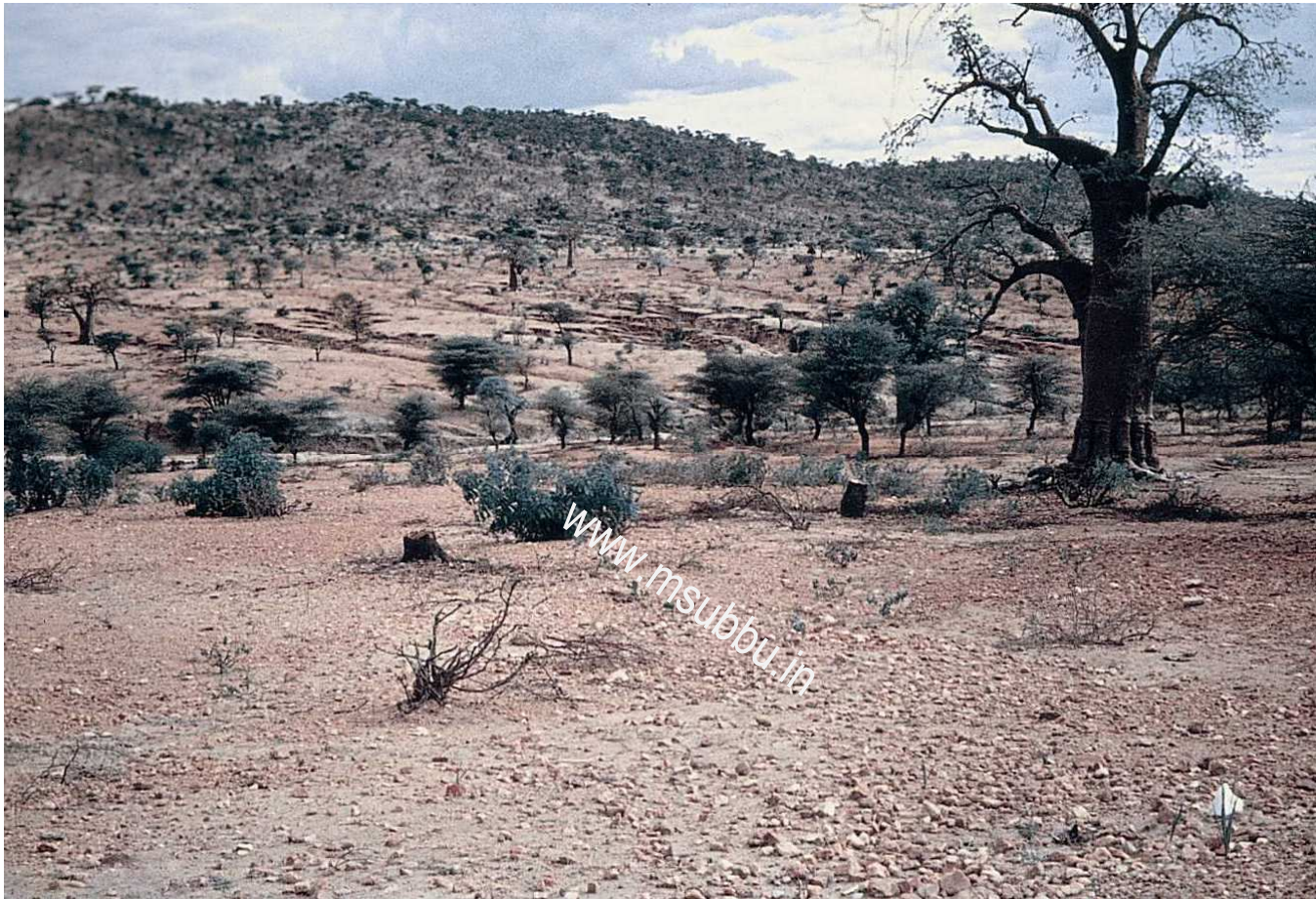


Overgrazing

- Overgrazing occurs when plants are exposed to intensive grazing for extended periods of time, or without sufficient recovery periods. It can be caused by either livestock in poorly managed agricultural applications, or by overpopulations of native or non-native wild animals.
- It reduces the usefulness, productivity, and biodiversity of the land and is one cause of desertification and erosion
- Overgrazing is also seen as a cause of the spread of non-native plants and weeds.

Ecological Impacts of Overgrazing

- Overgrazing typically increases soil erosion. Reduction in soil depth, soil organic matter and soil fertility impair the land's future productivity.
- Soil fertility can sometimes be mitigated by applying the appropriate lime and fertilizers. However, the loss of soil depth and organic matter takes centuries to correct. Their loss is critical in determining the soil's water-holding capacity and how well pasture plants do during dry weather



- An area almost completely denuded by overgrazing
- Most of what little rain may fall in this area runs off the surface and cannot benefit the soil's moisture reserves. The chances of vegetation re-establishing itself are correspondingly reduced



This communal grazing area on shallow stony soil never had a respite from grazing by cattle, sheep, goats. The soil surface was compacted and plant height was kept continually very short and sparse.



A bare land surface where overgrazing has removed much of the soil's protective cover, though protection from a high stone cover still remains

Water Logging

- An irrigated area is said to be waterlogged when the surplus water stagnates due to poor drainage or when the shallow water table rises to an extent that soil pores in the root zone of a crop become saturated, resulting in restriction of the normal circulation of the air, decline in the level of oxygen and increase in the level of carbon dioxide.
- Water logging is one of the major problems of land degradation in India.
- Unscientific management of soil, water and crops in irrigated lands and obstruction of natural drainage systems by various developmental activities are the main factors responsible for disrupting the balance of inflow and outflow of water, leading to water logging.
- The actual depth of water table, when it starts affecting the yield of the crops adversely, may vary over a wide range from zero for rice to about 1.5 meters for other crops.

Classification of Areas based on Water logging

Water logged Areas (Due to rise in water Table)	Water table within 2 meters of the land surface
Potential Areas for waterlogging	Water table between 2 to 3 meters below land surface
Safe Areas	Water table below 3 meters of land surface

Causes of Water Logging

- Water logging may be a result of both natural and man-made factors.
- Natural factors may include poor natural drainage as a consequence of unfavorable sub-soil geology like existence of hardpan at shallow depths; spilling of rivers resulting in submergence of agricultural lands; heavy storm rainfall coupled with poor natural drainage etc.
- Water logging is, however, caused mainly because of man made factors like deforestation and poor upkeep of watersheds; developmental activities such as construction of roads, bridges, railway lines and buildings resulting in choking of natural drainage; hydraulic pressure of water from upper irrigated areas resulting in seepage outcrop in low lying areas; introduction of irrigation without taking into account characteristics of soils and sub-soils for their irritability; seepage from canals, distributaries and watercourses

Soil Salinity

- Soil salinity is the salt content in the soil
- Since soil salinity makes it more difficult for plants to absorb soil moisture, these salts must be leached out of the plant root zone by applying additional water
- Salt affected soils are caused by excess accumulation of salts, typically most pronounced at the soil surface
- Salinity from irrigation can occur over time wherever irrigation occurs, since almost all water (even natural rainfall) contains some dissolved salts. When the plants use the water, the salts are left behind in the soil and eventually begin to accumulate.

Consequences of Soil Salinity

- detrimental effects on plant growth and yield
- damage to infrastructure (roads, bricks, corrosion of pipes and cables)
- reduction of water quality for users, sedimentation problems
- soil erosion ultimately, when crops are too strongly affected by the amounts of salts.