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Q17

Define the concept of carrying capacity of an ecosystem as relevant to an environment. Explain how understanding this concept is vital while planning for sustainable development of a region.

UPSC Civil Services Mains 2019 · GS III · 15 marks · Environment and Conservation

Conservation, environmental pollution and degradation, environmental impact assessment.

Core demand of the question

- Define carrying capacity of an ecosystem for the environment
- Explain why regional sustainable-development planning must use it
- Give Indian examples and recommendations

Revision summary

Carrying capacity is the maximum lasting load of people, livestock, tourists, or pollution an ecosystem can support.

It combines regenerative limits (water, soil, biomass) and assimilative limits (waste and fumes).

Regional plans for hills, coasts, cities, and aquifers must use it or they build overshoot.

Indian examples include **Western Ghats**, Himalayan towns, Punjab groundwater, and NCR air.

Tools are **EIA**, **CRZ**, tourist caps, ecological fiscal transfers, and published water-waste budgets.

Introduction

The **carrying capacity** of an ecosystem is the **maximum load** of people, livestock, tourists, or industry that the system can support **indefinitely** without a lasting fall in its ability to renew itself. It is not a single census number. It is a bundle of **regenerative** limits (water, soil, biomass) and **assimilative** limits (what waste, heat, and visitors the system can absorb). Planning that ignores it builds a hill town or a factory estate that looks like development until the spring dries or the slope fails.

Body**Defining the concept**

- In ecology, carrying capacity is the population of a species an environment can support given food, water, and habitat. For **human-environment planning**, it is extended to **tourism beds, built-up area, livestock units, and pollution load**.
- **Regenerative capacity**: how fast groundwater recharges, forests regrow, and fish stocks recruit.

- **Assimilative capacity:** how much sewage, plastic, and vehicle fumes a lake or a valley can take before it flips (eutrophication, smog, disease).
- Capacity is **not fixed**. Technology and behaviour can raise it (treatment plants, public transport) or cut it (climate change, deforestation). It is still a **hard ceiling** in a closed watershed or a coral atoll.
- **Related ideas: ecological footprint, planetary boundaries**, and India's **environmental impact assessment** - all try to keep development inside a budget of nature.

Why it is vital for regional sustainable development

- A **region** (a Himalayan district, a coastal taluk, a mining belt, a megacity) has a specific water, slope, and waste budget. National GDP growth does not cancel a local aquifer's arithmetic.
- **Land-use plans, tourist caps, industrial siting, and urban master plans** are carrying-capacity exercises whether they use the name or not. If they do not, the market fills every slope and every wetland.
- **Environmental Impact Assessment, Coastal Regulation Zone, and forest clearance** are legal tools; they work only if the baseline is a capacity study, not a project-wise bargain.
- **Disaster risk** is capacity exceeded: a hillside settlement above a landslide threshold, a city whose drainage capacity is below the monsoon.
- **Equity:** if elites take the water and the poor take the flood, "capacity" has already been allocated unjustly. Sustainable development must count **who** uses the capacity.

Indian illustrations

- **Western Ghats** (Gadgil and Kasturirangan debates): biodiversity and slope limits versus mining, dams, and plantation.
- **Himalayan towns (Shimla, hill stations, Kedarnath catchment): tourist and construction load versus water, waste, and slope; 2013 Uttarakhand floods** showed overshoot.
- **Punjab-Haryana groundwater:** paddy carrying capacity of the aquifer is already breached; "development" as rice surplus is unsustainable.
- **Delhi NCR air and Yamuna:** assimilative capacity of the airshed and the river is exceeded most winters.
- **Lakshadweep and coral coasts:** visitor and construction load versus reef and freshwater lens.
- **Wildlife landscapes:** tiger and elephant corridors have a habitat capacity; linear projects that ignore it raise conflict and crop loss for farmers.

Planning implications and recommendations

- Commission **regional carrying-capacity studies** (water, waste, energy, slope, biodiversity) **before** master plans and tourism policies, and publish them.
- Use **tourist and vehicle caps**, timed entry, and no-build zones on red slopes and recharge areas.
- Tie **Finance Commission ecological transfers** and scheme funds to staying inside local water and forest budgets.
- Prefer **circular waste and treated reuse** to raise assimilative capacity rather than dumping downstream.
- **For cities:** density along public transport, not endless sprawl that pretends capacity is infinite if the next river is tapped.

- Monitor with **real-time water, air, and visitor data**; revise the cap when climate shifts the regenerative rate downward.

Flow diagram

Carrying capacity -> Regenerative water forest

Carrying capacity -> Assimilative waste air

Regional plan -> Carrying capacity

Tourism paddy sprawl mining -> Overshoot

Overshoot -> Dry spring landslide flood smog

Caps EIA CRZ -> Regional plan

Conclusion

Carrying capacity is the lasting load an ecosystem can bear without losing renewal and waste-absorption. Regional sustainable development is the art of staying inside that load while still raising human well-being. Indian hills, aquifers, airsheds, and coasts already show overshoot. Plan with published capacity, caps, and equity - or call the next collapse an unexpected disaster.

Facts & figures

Regenerative vs assimilative

Regenerative capacity is renewal of water and biomass; assimilative capacity is how much waste the system can absorb.

EIA

Environmental Impact Assessment: project clearance that should rest on regional capacity, not only a site report.

CRZ

Coastal Regulation Zone rules that try to keep construction inside the carrying capacity of the shore and mangrove.

Western Ghats

Biodiversity hotspot where expert panels argued for graded ecological sensitivity as a capacity map for development.

Punjab aquifer

Paddy-wheat irrigation has drawn groundwater faster than recharge - a textbook regional overshoot of carrying capacity.