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GEOGRAPHY OPTIONAL

PAPER I

Geographical Thought Notes

The evolution of geographical thought, its schools and great debates, and every approach of human geography, with previous year questions.

Compiled by Arvind KrS

EVOLUTION OF THOUGHT | SCHOOLS OF THOUGHT | APPROACHES | CULTURE AND HDI

43	8	79	140
Chapters	Units	Previous year questions	Diagrams and figures



IN THIS BOOK

01 Nature and Evolution of Geographical Thought

02 Schools of Geographical Thought

03 Areal Differentiation, Regional Synthesis, Dichotomy and Dualism

04 Environmentalism

05 Quantitative Revolution and Locational Analysis

06 Radical, Behavioural, Human and Welfare Approaches

07 Languages, Religions, Secularisation and Cultural Regions

08 Human Development

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Geography Optional — Geographical Thought

Paper I · Human Geography: Geographical Thought

Mains 2027 Edition · Compiled October 2026

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How to read these notes

Every chapter is marked against the questions UPSC has actually asked on it, so the points that matter most stand out on the first read and are quick to find at revision.

Welfare geography is the study of who gets what, where, and how.

Yellow marker: key point. A point that carries the ideas UPSC has asked about in this chapter. Read these first, and make sure each one is in your answer.

Neo-determinism is a revised, moderate form of environmental determinism.

Blue marker: definition. The cleanest definition of a term, ready to open an answer with.

Between the wars and just after 1945, geographers in France, Britain and the United States worked within the **regional paradigm**.

Saffron underline: PYQ term. A key term or phrase that appears in this chapter's previous year questions.

Course of the Revolution

PYQ 2022 · 2018 · 2016 +3

PYQ tag on a heading. The years in which UPSC asked about this section. Sections without a tag are background or linking material.

PYQ RADAR **7** questions Last asked **2022**

PYQ radar. At the start of each chapter: how many times the topic has been asked, and how recently. The contents page shows the same count for every chapter.

Suggested method. First read: the whole chapter. Revision: the yellow and blue marks, the tagged headings and the PYQ list at the end of the chapter. Last week before Mains: the PYQ list alone, answering each question in your head from the marked points.

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UNIT 01 | 10 CHAPTERS

Nature and Evolution of Geographical Thought

The nature of geography and the evolution of geographical thought, from the classical world to the eve of modern geography.

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GEOGRAPHY OPTIONAL | PAPER I · HUMAN GEOGRAPHY

Evolution of Geographical Thought

PYQ RADAR **2** questions Last asked **1999** 1999 · 1989

CONTENTS

01 Periods of Geographical Thought
02 Pre-Modern Foundations
03 Modern Geography
04 Evaluation: Continuity, Change and Convergence
05 Previous Year Questions

- **Geographical thought** is the history of the ideas, concepts and methods through which people have tried to describe and explain the **earth as the home of humankind**.
  - It records, in Preston E. James's phrase, the effort to gain **"more and more logical and useful knowledge"** of the human habitat and of humanity's spread over the earth.
- Geography has a **longer genealogy than almost any other science**. The earliest written records already contain observations about places, routes, seasons and peoples.
  - Each civilisation drew on its own setting. Astronomy flourished under the clear skies of **Chaldea, Assyria and Babylonia**, geometry on the surveyed flood lands of the **Nile**, and physical geography in **Greece**, with its varied relief and indented coastline.
- The subject became a **modern university discipline only in the 1870s**. Its history is therefore a long pre-scientific stage followed by about 150 years of rapid, contested change.
- That history is often described as one of **dichotomies and abandoned theories**: each generation's explanations failed to satisfy the next, and the search for better ones produced the **paradigms** of the discipline.

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01 Periods of Geographical Thought

Why the History of Ideas Matters

- **Contextual history:** ideas are best understood in the **social, political and intellectual setting** in which they arose, not judged only as true or false.
  - Determinism matched the age of empire. Quantification matched post-war faith in science and planning. Radicalism matched the protests of the late 1960s.
  - **John Kirtland Wright** (1926) called for a history of geographical ideas. **David Stoddart** (1986) dated modern geography to **1769**, when James Cook entered the Pacific with trained scientific observers.
- **Three persistent questions** run through every period:
  - **Where is it?** Absolute and relative location.
  - **What is it like?** Description and classification.
  - **Why is it there, and what does it mean?** Explanation, which may be inductive or deductive.
- **Persistent themes:** the **man–nature relationship**, the **region and areal differentiation**, and **spatial organisation**. Each period gives one of them priority.

A Working Periodisation

- **Richard Hartshorne's** *The Nature of Geography* (1939) and *Perspective on the Nature of Geography* (1959) were the first major attempts to trace the discipline's past in order to define its nature.
  - The periodisation below is the conventional one used in the subject. It is a teaching scheme, not Hartshorne's own classification.

PERIOD	APPROX. TIME	CHARACTER	KEY FIGURES
Classical antiquity	8th c. BCE–5th c. CE	Mathematical and descriptive geography; the spherical earth measured	Homer, Herodotus, Eratosthenes, Strabo, Ptolemy
Medieval period	5th–15th c.	Europe's "dark age"; Arab, Indian and Chinese scholarship leads	Al-Masudi, Al-Biruni, Al-Idrisi, Ibn Battuta, Ibn Khaldun
Renaissance and Age of Exploration	15th–17th c.	Voyages, new maps and instruments; experience overturns authority	Columbus, Vasco da Gama, Magellan, Mercator
Pre-classical (foundations)	17th–18th c.	Philosophical basis of geography as a discipline	Bernhard Varenius, Immanuel Kant
Classical period	c. 1790–1859	Geography as a unified scientific study	Alexander von Humboldt, Carl Ritter

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PERIOD	APPROX. TIME	CHARACTER	KEY FIGURES
Post-classical / modern	1859–1950	Professional geography, national schools, great debates	Ratzel, Richthofen, Hettner, Vidal de la Blache, Davis, Hartshorne
Contemporary	1950 onwards	Successive and coexisting paradigms	Schaefer, Haggett, Harvey, Tuan, Smith, Soja

GEOGRAPHICAL THOUGHT · EVOLUTION

From Earth Description to Spatial Science and Beyond

Seven broad periods of geographical thought, the thinkers who defined each and the change each period brought to the discipline.

PERIOD	KEY THINKERS AND WORKS			WHAT CHANGED
Classical antiquity 8th c. BCE – 5th c. CE	**Homer · Hecataeus · Herodotus** Literary geography: descriptions of lands and peoples	**Eratosthenes (c. 276–194 BCE)** Coins 'geographia'; measures the earth's circumference	**Strabo · Ptolemy (c. 150 CE)** Geographica (17 books); latitude–longitude world map	Two traditions born: mathematical and descriptive
Medieval period 5th – 15th c.	**Europe: Church and T-in-O maps** Inquiry curbed; classical learning largely lost in the West	**Al-Masudi · Al-Biruni · Al-Idrisi** Arab scholars translate, travel and map (Tabula Rogeriana, 1154)	**Ibn Battuta · Ibn Khaldun** Rihla; Muqaddimah (1377) links climate to ways of life	Arab, Indian and Chinese learning keeps geography alive
Renaissance and exploration 15th – 17th c.	**Columbus 1492 · da Gama 1498** Sea routes to the Americas and India	**Magellan–Elcano 1519–22** First circumnavigation proves a connected world ocean	**Mercator 1569** Projection with constant compass bearings for navigators	Experience overturns authority; a true world map
Pre-classical foundations 17th – 18th c.	**Bernhard Varenius** Geographia Generalis (1650): general vs special geography	**Immanuel Kant** Lectures from 1756: history studies time, geography space		Philosophical basis for a discipline
Classical period c. 1790 – 1859	**Alexander von Humboldt** Kosmos (1845–62): empirical, systematic, ecological	**Carl Ritter** Die Erdkunde (1817–59): regional, comparative, earth as home of man		Geography becomes a unified science
Post-classical / modern 1859 – 1950	**Ratzel · Richthofen · Hettner** Anthropogeographie (1882, 1891); chorology	**Vidal de la Blache · Febvre** Genre de vie; 'possibilism' named (1922)	**Davis · Semple · Sauer · Hartshorne** National schools; The Nature of Geography (1939)	University chairs from the 1870s; the great dichotomies
Contemporary paradigms 1950 – today	**Schaefer 1953 · Haggett 1965** Quantitative revolution and spatial science	**Kirk · Lynch · Tuan · Relph** Behavioural and humanistic reaction (1960s–70s)	**Harvey 1973 · Smith 1977 · Soja 1989** Radical, welfare, postmodern and feminist geographies	Coexisting paradigms; space as socially produced

Before 1800

- Description and measurement of a widening known world
- Greek theory, Arab scholarship, European voyages

1800–1950

- Humboldt and Ritter found a unified science
- Chairs, national schools and great dichotomies

Since 1950

- Spatial science, then behavioural, humanistic, radical and welfare reactions
- Postmodern, feminist, GIS and Anthropocene geographies coexist

A conventional teaching periodisation; dates are approximate and the periods overlap.

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02 Pre-Modern Foundations

Classical Antiquity

- **Classical antiquity** is the long period of Mediterranean civilisation centred on **ancient Greece and Rome**.
  - It is usually counted from the epics of **Homer** (8th–7th century BCE) to the decline of the Western Roman Empire (5th century CE). It shades into the early Middle Ages during late antiquity (c. 300–600 CE).
- **Greece** sat at the crossroads of ancient trade routes. Its scholars gathered knowledge from **Egypt, Mesopotamia and Persia**, and from Alexander's eastern campaigns, and built it into theory.
  - Their horizon stretched from **Spain and Gaul** to the **Russian steppes**, the **Indus** and **Ethiopia**.
- **Two traditions** emerged and still run through the subject:
  - **Mathematical tradition:** fixing locations, shape and size of the earth. Thales and Anaximander began it, Aristotle argued for a **spherical earth**, and **Eratosthenes** (c. 276–194 BCE) carried it to its height.
    - Eratosthenes coined the word *geographia* ("earth description") and computed the earth's circumference remarkably close to the true value.
    - **Hipparchus** proposed locating places by latitude and longitude. **Ptolemy** (c. 150 CE) built maps on that grid, the root of the **graticule** and map projection.
  - **Literary or descriptive tradition:** describing lands and peoples. It runs from **Hecataeus** and **Herodotus** to **Strabo**, whose 17-book *Geographica* is the classic regional description of the known world.
- **Rome** added practical, administrative geography: road itineraries, surveys and the mapping of Britain and western Europe for a governing empire.
  - Parallel traditions grew in **China** (the *Yu Gong*, Pei Xiu's grid maps) and in **India** (the Puranic *dvipas*, the *Surya Siddhanta* and Aryabhata's rotating earth).
- **Limitation:** theory ran far ahead of observation. Ptolemy's authority, including his underestimate of the earth's size, held for some 1,300 years.

The Medieval Period: Europe's Dark Age and the Arab Ascendancy

- In Europe, the **Middle Ages** (c. 476 CE to the Renaissance) were long called the **"Dark Ages"** for geographical learning.
  - The **Church** controlled education. Inquiry that questioned scripture risked the charge of **blasphemy**.
  - Classical knowledge was largely lost in the West. Maps became symbolic **T-in-O maps** with Jerusalem at the centre.
- The **Arabs** carried the subject forward between the 8th and 14th centuries.
  - Under the **Abbasid caliphs**, Greek and Indian works were translated into Arabic (Ptolemy's *Almagest* among them), and trade across the Indian Ocean and Asia's land routes gave first-hand knowledge.
  - The word **monsoon** comes from the Arabic *mausim* (season).
  - **Al-Masudi** (d. 956) wrote on climate and on human character. **Al-Biruni** (973–1048) wrote *Kitab al-Hind* (c. 1030) and measured the earth's radius. **Al-Idrisi** made a world map for Roger II of Sicily

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(1154). **Ibn Battuta** (1304–1368/69) travelled about 120,000 km. **Ibn Khaldun's** *Muqaddimah* (1377) linked climate to ways of life.

- The **Crusades** and contact with Arab Spain brought **Aristotle and Ptolemy** back to Europe, where they were reworked, sometimes in error.
- In the late Middle Ages, travellers such as **Marco Polo** (in Asia 1271–1295) brought new information. Portolan sea charts began to improve navigation. These prepared the ground for the Renaissance.

The Renaissance and the Age of Exploration

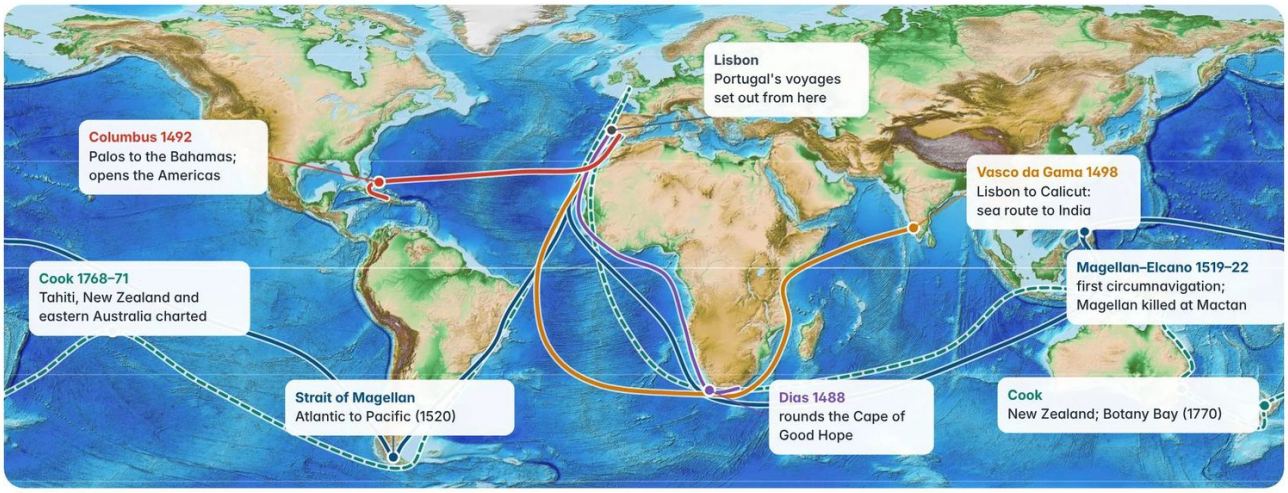
- The **Renaissance** revived classical learning and **faith in human capability** over dogma. Rulers and merchants backed the search for a sea route to the spices of India and the East.
  - **Push factors:** the Ottoman hold on land routes after 1453, rivalry among the new monarchies, and the profits of the spice trade.
  - **Enabling tools:** the magnetic compass, astrolabe and quadrant, the caravel, and printed maps.
- **Major voyages:**
  - **Bartolomeu Dias** rounded the Cape of Good Hope (1488).
  - **Christopher Columbus** reached the Caribbean (1492).
  - **Vasco da Gama** reached Calicut (1498).
  - **Amerigo Vespucci** sailed along South America (1499–1502). His recognition of a "New World" led **Martin Waldseemüller** to name it *America* (1507).
  - **Ferdinand Magellan's** expedition, completed by Elcano, sailed round the world (1519–22).
  - **James Cook** mapped the Pacific, **New Zealand** and eastern **Australia** (1768–79).
- **Effects on geography:**
  - It produced a **true world map** for the first time. **Gerardus Mercator's** projection (1569) answered the navigator's need for constant compass bearings.
  - **Experience triumphed over authority.** Observed fact overturned inherited theory, which helped give rise to experimental science.
  - New data appeared on currents, winds, tides, climates, plants and peoples. **Cultural relativism** slowly grew from contact with other societies.
  - It also opened the age of **colonial expansion**. Geographical knowledge became a tool of empire, a link later critics stressed.

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GEOGRAPHICAL THOUGHT · AGE OF EXPLORATION

The Voyages That Remade the World Map

Five landmark voyages, from Dias in 1488 to Cook in 1771, joined the oceans into one connected system and turned geography from received authority to observation.



Why they sailed

- Ottoman hold on land routes after 1453
- Spice trade profits; rival monarchies
- Compass, astrolabe, caravel, printed maps

What geography gained

- A true world map; Mercator's projection (1569)
- Data on winds, currents, climates and peoples
- Observation over inherited authority

What it set in motion

- Colonial expansion and its maps
- Comparative study of societies
- Cook's scientific voyages: modern geography's start

Routes simplified. Relief: NOAA ETOPO1.

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The Pre-Classical Phase: Philosophical Foundations

- In the 17th and 18th centuries, scholars laid the **philosophical basis** that made geography possible as a discipline.
- **Bernhard Varenius** (1622–1650), in *Geographia Generalis* (1650):
  - He divided geography into **general** geography (laws of the whole earth) and **special** geography (description of particular regions). This is the root of the later **systematic–regional dualism**.
  - He accepted the heliocentric universe of **Copernicus, Kepler and Galileo**.
- **Immanuel Kant** (1724–1804) lectured on physical geography at Königsberg from 1756 to 1796.
  - He classified knowledge **logically**, by kinds of things, which gives the systematic sciences. He also classified it **physically**, by where and when things occur: **history** studies phenomena in **time**, **geography** in **space**.
  - This gave geography a respected place among the sciences as a **chorological** (place-centred) study. Hettner and Hartshorne later built on it.

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03 Modern Geography

The Classical Period: Humboldt and Ritter

- **Alexander von Humboldt and Carl Ritter** (1769–1859 and 1779–1859) turned scattered knowledge into a **unified scientific geography**. Both died in **1859**, the year Darwin published *On the Origin of Species*.
  - **Humboldt:** explored the Americas (1799–1804) and drew the first **isotherms**. He described altitudinal vegetation zones on Chimborazo. His *Kosmos* (1845–62) presented the earth as a **harmonious whole**. His method was **empirical, systematic and ecological**.
  - **Ritter:** wrote *Die Erdkunde* (19 volumes, 1817–59) and held Berlin's first chair of geography (1820). His approach was **regional, comparative and teleological**. He stressed the earth as the **home of man** and the **unity in diversity** of regions.
- Together they set up the two lasting approaches, **systematic** (Humboldt) and **regional** (Ritter).

The Post-Classical Period: Institutions, Schools and Debates

- **Crisis after 1859:** knowledge was splitting into separate sciences of nature and of society. Geography, which studied both, faced an **identity crisis**: what was left for it to study?
- **Institutionalisation:** the first university chairs came in the **1870s**. They began in Germany, where Prussia resolved in **1874** to create chairs in all its universities, and spread to France, Britain and the United States.
  - **Darwin's ideas** of evolution, adaptation and struggle shaped the new discipline.
- **National schools** grew up, each with its own emphasis:
  - **German**: Ratzel, Richthofen, Hettner and Penck.
  - **French**: Vidal de la Blache, Brunhes and the *genre de vie*.
  - **British**: Mackinder, Herbertson, Roxby and Stamp.
  - **American**: Davis, Semple, Huntington, Barrows and Sauer.
  - **Russian/Soviet**: Dokuchaev, Anuchin and Baransky.
- **The great dichotomies** (late 19th to mid-20th century) set the agenda of the subject.
  - **Physical vs human geography:** both are now accepted as necessary. Human geography explains the human factor in environmental change and growing technological power.
  - **Man vs environment:** this is the debate between **determinism and possibilism**.
    - **Friedrich Ratzel's** *Anthropogeographie* (vol. 1, 1882; vol. 2, 1891) gave determinism its scientific form. His second volume, on the distribution of peoples, left more room for human agency.
    - **Paul Vidal de la Blache** and the French school stressed **choice within nature's possibilities**. **Lucien Febvre** named this **possibilism** (1922).
    - **Griffith Taylor's neo-determinism** (stop-and-go determinism) held that nature sets the limits and route, and humans set the pace.
      - For example, rainforest cannot be grown in the Sahara, and the tundra's climate limits farming. Humans may use what nature offers, but within its limits.

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- **General (systematic) vs special (regional) geography:** this dispute ended in the **Hartshorne–Schaefer debate**.
  - **Hartshorne** (1939) saw geography as the study of **areal differentiation**, mainly **idiographic** and descriptive of the unique.
  - **Fred K. Schaefer** (1953) attacked this **exceptionalism** and called for a **nomothetic**, law-seeking spatial science.

The Quantitative Revolution and Spatial Science (1950s–1960s)

- **Post-war conditions** encouraged the change. These included wartime operational research, computers, planning needs, and the prestige of the physical sciences under **logical positivism**.
- The **quantitative revolution** produced the following:
  - **Statistics, mathematics and models** became the tools of geography. The **Washington school** (William Garrison), William Bunge's *Theoretical Geography* (1962), Peter Haggett's *Locational Analysis in Human Geography* (1965) and Chorley and Haggett's *Models in Geography* (1967) were landmarks.
  - Older location theories were revived and extended: **von Thünen, Weber, Christaller and Lösch**.
  - It rested on **simplifying assumptions**, such as the **isotropic surface** and the **rational economic man**.
  - Geography moved from description to **locational analysis** and from regions to **spatial organisation**.
- **Weaknesses:** its laws were **normative**, describing ideal rather than real behaviour. It ignored values, perception and the dynamic behaviour of people.

The Critical Reaction: Behavioural and Humanistic Geography (1960s–1970s)

- The **critical revolution** arose from **dissatisfaction** with spatial science. It questioned normative assumptions and spurious generalisations, and models that did not reflect reality. It developed along two lines:
- **Behavioural geography:**
  - It replaced economic man with the **perceiving, deciding person**. Key works include **William Kirk's** behavioural environment, **Kevin Lynch's** *The Image of the City* (1960), **Julian Wolpert's** satisficer (1964) and **mental maps**.
  - It **kept** generalisation and quantification, as a **refined form of positivism**.
- **Humanistic geography:**
  - It **rejected** law-making and quantification. Every person and place is unique, so the aim is **understanding** (*verstehen*) of meaning, values and **sense of place**.
  - It drew on **phenomenology, existentialism and idealism**: **Yi-Fu Tuan** (*Topophilia*, 1974), **Edward Relph** (*Place and Placelessness*, 1976) and **Anne Buttimer**.

The Relevance Movement: Radical and Welfare Geography (1970s)

- The late 1960s brought the **Vietnam War, civil-rights struggles, urban riots, poverty and environmental crisis**. Geographers asked what their work was **for**.
  - **Wilbur Zelinsky's** "Beyond the Exponentials" (1970) urged geographers to confront the crises of growth. Social relevance became the measure of research.

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- **Radical geography:** it used **Marxist** and anarchist ideas. The journal *Antipode* was founded in 1969, and **William Bunge** led the **Detroit Geographical Expedition**. **David Harvey's** *Social Justice and the City* (1973) explained spatial inequality through capitalism and called for structural change.
- **Welfare geography:** this is the liberal-reformist stream. **David M. Smith** (1977) asked **"who gets what, where, and how"** and sought **territorial social justice** within the existing system.
  - Welfare geography is reformist and policy-oriented; radical geography seeks structural change. Both put **inequality** at the centre.

Postmodern, Feminist and Contemporary Geographies (1980s onwards)

- **Postmodern and feminist geographies** questioned grand theories and universal truths. They stressed **difference, identity, gender and the voices of the marginalised**.
  - Key works: **Edward Soja's** *Postmodern Geographies* (1989) and the **Women and Geography Study Group's** *Geography and Gender* (1984).
- **Space, place and locality** returned to the centre of the subject. Space came to be seen as **socially produced**, through Henri Lefebvre and the **socio-spatial dialectic**.
  - **Time geography** linked space and time in everyday life.
  - **New regional geography** revived the region in a new form.
- **The cultural turn** of the 1990s was followed by **GIS and GIScience**, remote sensing and big data, which made quantitative methods newly powerful.
- **Current directions: critical physical geography**, **political ecology**, the **Anthropocene**, climate change and disaster risk, and **decolonial geographies** that challenge the **Eurocentric** origins of the discipline.

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04 Evaluation: Continuity, Change and Convergence

- **Paradigm view:** using **Thomas Kuhn's** *The Structure of Scientific Revolutions* (1962), Haggett and Chorley read geography's history as a series of **paradigm shifts.** Each shift follows a crisis in the ruling model.
- **Coexistence, not replacement:** in practice, earlier approaches **survive alongside** newer ones. Regional study, spatial analysis, behavioural work and political economy all continue.
  - This makes geography **multi-paradigmatic** rather than a neat succession of revolutions.
- **Continuity of themes:** man–nature relations, areal differentiation and spatial organisation recur in every period. They are reworked rather than abandoned.
  - Environmentalism, for example, has returned through climate change and sustainability.

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- **Convergence:** by the 1990s, earlier divisions had softened into **complementary perspectives**. These were regional and systematic, idiographic and nomothetic, and humanistic and Marxist.
- **Eurocentrism:** the received history centres on Europe and North America. **Arab, Indian and Chinese** traditions and colonial knowledge-making are now being written back into it.

APPROACH	ERA	PHILOSOPHY	VIEW OF SPACE	METHOD
Regional / areal differentiation	to 1950s	Kantian chorology, empiricism	Container of unique regions	Description, synthesis
Quantitative / spatial science	1950s–60s	Logical positivism	Absolute, geometric	Models, statistics
Behavioural	1960s–70s	Modified positivism, cognitive psychology	Perceived space	Surveys, mental maps
Humanistic	1970s	Phenomenology, existentialism, idealism	Lived space, place	Interpretation, ethnography
Radical / welfare	1970s	Marxism / liberal welfare economics	Socially produced, unequal	Political economy, social indicators
Postmodern / feminist	1980s onwards	Post-structuralism, feminism	Relational, plural	Discourse, qualitative, mixed

Previous Year Questions

1999 — Describe the sequence of major paradigm shifts in geographic thought during the twentieth century.

1989 — Write an essay on the contribution of European geographers to the development of geographic thought.

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UNIT 05 | 6 CHAPTERS

Quantitative Revolution and Locational Analysis

Quantitative revolution and locational analysis.

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GEOGRAPHY OPTIONAL | PAPER I · HUMAN GEOGRAPHY

Quantitative Revolution

26

PYQ RADAR **7** questions Last asked **2022** 2022 · 2018 · 2016 · 2009 · 1998 · 1990 · 1986

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01 Background, Philosophy and Objectives
02 Course of the Revolution
03 Methods, Approaches and Models
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05 Previous Year Questions

- The **quantitative revolution** is the change in the spirit, method and purpose of geography during the 1950s and 1960s, when statistical and mathematical techniques, theory and model-building replaced regional description as the core of the discipline.
  - Geography moved from an **idiographic** concern with the unique character of regions, the tradition of **areal differentiation**, to a **nomothetic** search for generalisations, laws and models of spatial structure.
  - It redefined geography as a **spatial science**: the study of the spatial arrangement of phenomena, their location, distribution and interaction on the earth's surface.
- The origin of the phrase is unclear, but the Canadian geographer **Ian Burton** gave it currency in **"The Quantitative Revolution and Theoretical Geography"** (*The Canadian Geographer*, 1963). In the same paper he argued that the revolution was already over, because its ideas had become conventional wisdom.
- In its simplest form, the quantitative revolution means applying statistical and mathematical techniques, theorems and proofs to the understanding of geographical systems. Its deeper aim was to give geography a theoretical and philosophical foundation comparable to the other sciences.

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01 Background, Philosophy and Objectives

Why the Revolution Happened

- **Dissatisfaction with regional geography.** By mid-century, regional work was widely judged naive and encyclopaedic.
  - Many regional texts piled up unrelated physical and human facts. They relied on Herbertson's **natural regions** and treated every region as unique, so they offered no theory and no generalisation.
  - **T. W. Freeman** (1961) summed up the charge: regional geographers had tried to include too much and to explain too little.
- **Wartime experience. Edward A. Ackerman** (1945) found that geographers working with other social scientists in US wartime intelligence had thin systematic knowledge. He called for deep topical (systematic) specialisation.
- **An institutional crisis. Harvard University abolished its geography department in 1948**. President **James B. Conant** reportedly declared that geography was "not a university subject", and several private American universities followed.
  - The threat of closure pushed American geographers to find rigorous new research programmes.
- **The Schaefer–Hartshorne debate. Fred K. Schaefer's** "Exceptionalism in Geography" (1953) attacked the claim that geography's regions were too unique for laws. He defined geography as the **science of spatial arrangements**, seeking **morphological (pattern) laws**.
  - **Richard Hartshorne** replied (1955, 1959). By the late 1950s, however, younger geographers had sided with Schaefer. The **Hartshorne–Schaefer debate** became the charter of the new geography.
- **The prestige of science after 1945.** Operational research, computers and the success of physics and economics made **quantification** look like the route to useful, predictive knowledge. Planners also needed forecasts for cities, transport and regions.
- **Ideas borrowed from other fields.** Burton called geography a "following" discipline that imports its main currents of thought. Four works from outside geography fed the movement:
  - **John von Neumann and Oskar Morgenstern**, *Theory of Games and Economic Behavior* (1944): strategic choice expressed mathematically.
  - **Norbert Wiener**, *Cybernetics* (1948): feedback, control and systems that cross disciplinary boundaries.
  - **John Q. Stewart**, "Empirical Mathematical Rules Concerning the Distribution and Equilibrium of Population" (*Geographical Review*, 1947): old geographical questions recast as physical regularities.
  - **George Kingsley Zipf**, *Human Behavior and the Principle of Least Effort* (1949): people organise their lives to minimise effort, including the effort of movement.
- **A wider movement in science.** Quantification spread first through the **physical**, then the **biological** and, by the 1950s, most **social sciences**, notably economics, psychology and sociology. It touched anthropology and political science less, and narrative history hardly at all.

- **A probabilistic turn.** The 19th-century mechanistic outlook had produced the cause-and-effect reasoning of **environmental determinism**. The quantifiers shared its search for causes and laws, but used **statistics**, which replace inevitable effect with probable trend.
  - As the revolution matured, its explanations became **indeterministic**: predictable order in the aggregate, randomness in the individual.

Positivism: The Philosophy Behind It

- The revolution adopted **positivism**, the view that knowledge must rest on observable, verifiable facts and that one scientific method serves both the natural and the social sciences.
  - **Auguste Comte** founded positivism in the 1820s–30s. The **logical positivists** of the Vienna Circle later added that only empirically testable statements are meaningful.
  - Geographers took from it the **hypothetico-deductive method**: state a hypothesis, derive testable predictions, test them against data, and build verified hypotheses into **laws and theories**. **David Harvey's** *Explanation in Geography* (1969) set out this method in full.
- **What kind of laws?** Geography cannot run controlled experiments, so its laws could rarely be universal like the law of gravity.
  - **Reginald Golledge and Douglas Amedeo** (1968) showed that "law" itself has many meanings: deterministic, statistical, probabilistic, equilibrium, developmental and cross-sectional.
  - Most geographical generalisations turned out to be **statistical or probabilistic laws**, which state what the majority of cases will probably do.
- Two allied outlooks supported positivism:
  - **Empiricism:** knowledge comes from direct observation and measurement.
  - **Functionalism:** the parts of a whole are studied through their interrelationships. This led to **systems analysis**.
- Positivism set science apart from metaphysics and religion. In geography it meant that only statements which could be checked against measured data counted as explanation, and that values had no place in research.

Objectives

- **Make geography a science.** It should no longer be a narrative "earth description". It should explain spatial patterns rationally and objectively.
- **Use precise language.** Mathematical symbols would replace literary description, as when Köppen's code *Af* stands for a tropical rainforest climate.
- **Make accurate generalisations** about the locational order of phenomena.
- **Test hypotheses** and build **models, theories and laws** that can predict.
- **Find optimal locations** for economic activities, where costs are least and returns highest.
- **Give the subject a sound philosophical and methodological base**, ending its dependence on borrowed descriptions.

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Assumptions of the Models

- The models of the period worked under ideal conditions so that a clean, general solution could be derived:
  - **Rational economic man**, who always optimises profit or minimises cost.
  - Perfect knowledge of the environment, its resources and its alternatives.
  - An **isotropic surface**: a flat, uniform plain with equal movement in all directions and uniform prices and resources.
  - **No normative questions.** Values, beliefs, customs, taboos and emotions were kept out of scientific explanation.
- These assumptions made the models elegant. They were also the main target of later critics.

A New View of Space

- Space became the organising concept. Schaefer's claim that spatial relations alone are geography's concern made **space**, not the region, the subject's core idea.
  - **J. Wreford Watson** (1955) called geography a "discipline in distance", and **Edward Ullman** made **spatial interaction** its central theme.
- Absolute to relative space. **James M. Blaut** distinguished **absolute space**, a fixed container with its own reality, from **relative space**, a set of relations between events, bound to time and process.
  - Generalisation needs **relative space**, measured in travel time, cost or connectivity, because only then can cases be compared and replicated. Location theory therefore moved from absolute to relative location.
  - **Pip Forer** (1978) later spoke of "plastic space", which shrinks and stretches as transport and technology change.
- Two working concepts followed:
  - **Spatial interaction:** the interdependence between places, through flows of goods, people, money and messages.
  - **Spatial structure:** the resulting arrangement of points, lines and areas, read as **geometry**.
- The geometric tradition revived. Chorley and Haggett (1965) traced it back to the Greek idea of geography. They argued that geometry could weld human and physical geography together and restore cartography to the centre.

New Dualisms the Revolution Raised

- Quantification sharpened several old tensions and created new ones:

QUANTITATIVE SIDE	TRADITIONAL SIDE	THE TENSION
Measurement by instruments	Observation through the senses	Is a measured fact more real than a field impression?

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QUANTITATIVE SIDE	TRADITIONAL SIDE	THE TENSION
Rational analysis	Intuitive perception	Can the “personality” of a region be calculated?
Laboratory and model constructs	Lived, field experience	Do ideal models describe real places?
Continuous change, processes	Discrete cases, regions	Is the unit of study a flow or a place?
Nomothetic, law-seeking	Idiographic, describing the unique	The core methodological divide

- Treating each pair as a choice between right and wrong led nowhere. The lasting outcome was a broader view in which both sides of each pair have a place, and the wider dispute runs through the **dichotomies of geography**.

02 Course of the Revolution

PYQ 2022 · 2018 · 2016 +3

Phases

PHASE	PERIOD	CHARACTER	LANDMARKS
Genesis (forerunners)	1826–1950	Isolated models and empirical regularities, mostly from economists and physicists	von Thünen (1826), Ravenstein’s laws of migration (1885), Weber (1909), Christaller (1933), Jefferson’s primate city (1939), Zipf’s rank-size rule (1949)
Revolution (zenith)	c. 1953–1970	Quantification becomes the mainstream in Anglo-American geography	Schaefer (1953), Weaver (1954), Bunge (1962), Burton (1963), Haggett (1965), *Models in Geography* (1967), Harvey (1969)
Reaction and maturity	1970s–1980s	Critique; quantitative work continues as one approach among many	Behavioural, humanistic and radical responses; entropy and spatial-interaction models; spatial statistics
Renewal	1990s onwards	Computers revive quantitative work as GIScience	GIS, remote sensing, local statistics, critical and feminist quantitative work

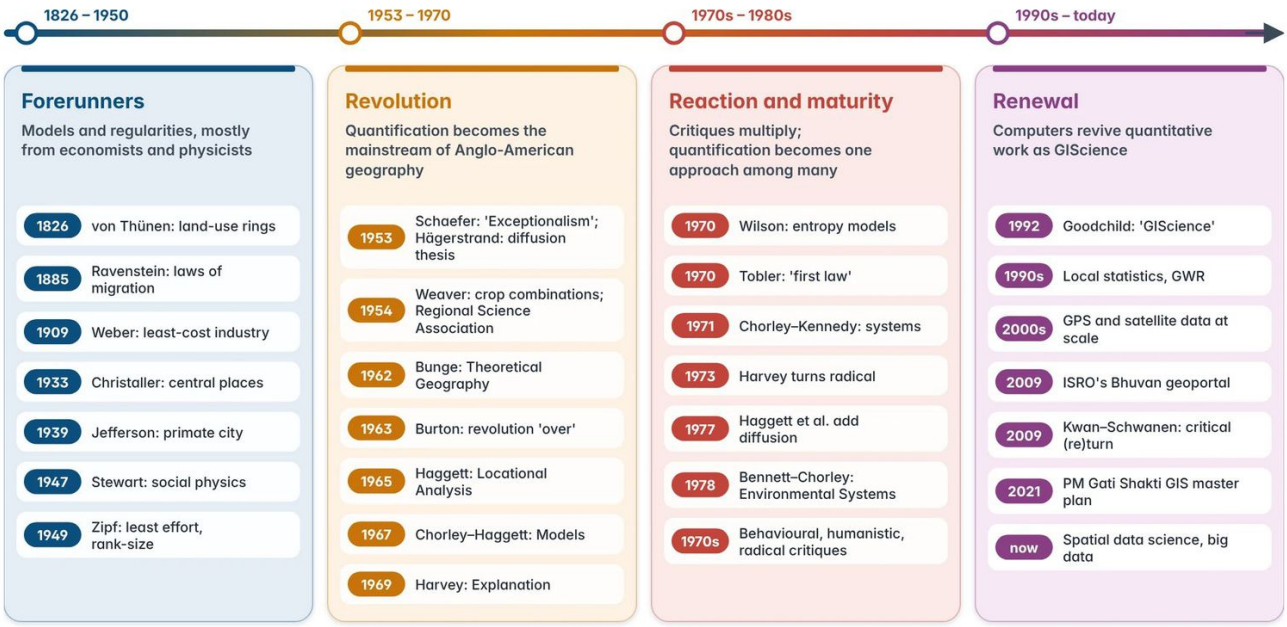
- **Momentum:** quantification began in the **late 1940s**, gathered pace after Ackerman and Schaefer, and **peaked in 1957–1960**. By **1963**, Burton could argue that its ideas had become accepted wisdom.
- **Decline of dominance, not of use:** from the **early 1970s** the revolution lost its claim to be the whole of geography. Even **Harvey**, once its chief methodologist, declared in 1973 that it had **run its course**. Quantitative methods never disappeared.

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GEOGRAPHICAL THOUGHT · QUANTITATIVE REVOLUTION

Four Phases of the Quantitative Revolution

From scattered location models to a mainstream spatial science, then critique, then renewal through GIS: the landmark works of each phase.



What drove it

- Weak, descriptive regional geography
- Post-war faith in science, computers and planning
- Schaefer's attack on 'exceptionalism'

What it delivered

- Statistics, models and location theory
- Geography as a spatial science
- Centres at Seattle, Lund and Cambridge

What followed

- Behavioural, humanistic and radical critiques
- Quantitative methods kept, but as tools
- GIS and spatial data science today

Phase boundaries are approximate; quantitative methods never disappeared after the 1970s. lotusarise.com

Centres and Pioneers

- **University of Iowa:** led by **Harold H. McCarty**, with **Schaefer**. It worked on laws of association between geographical patterns.
- **University of Wisconsin: John C. Weaver's crop-combination method** (1954) applied the standard deviation to agricultural regions. **Arthur H. Robinson** developed statistical cartography with the climatologist **Reid Bryson**.
  - Weaver's method has since been applied to Indian districts to map **crop combination regions**.
- **University of Washington, Seattle:** the most productive centre. **William L. Garrison** and **Edward L. Ullman** brought **location theory** and **central place theory** into urban, economic and transport geography.
  - Garrison's students included **Brian J. L. Berry, William Bunge, Michael Dacey, Duane Marble, Richard Morrill and Waldo Tobler**. They later led the new geography across North America.
- **Princeton:** the astronomer **John Q. Stewart** and the geographer **William Warntz** built **social physics** (*macrogeography*). They modelled population "mass", distance and time on physical laws, and Warntz wrote *Toward a Geography of Price* (1959).

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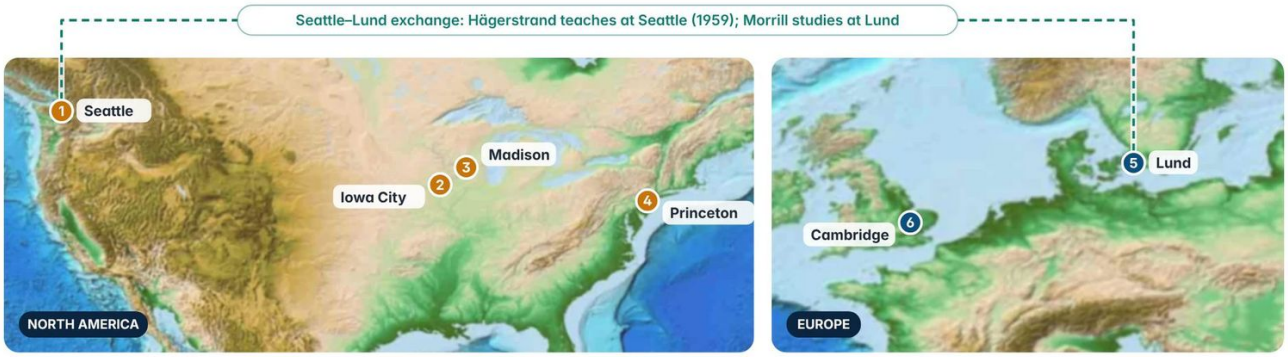
- **Lund, Sweden: Edgar Kant** introduced Christaller and Lösch there. **Torsten Hägerstrand's** thesis (1953, translated as *Innovation Diffusion as a Spatial Process*, 1967) built a **stochastic (Monte Carlo) model of diffusion**.
  - Hägerstrand taught at Seattle in 1959. Morrill studied at Lund, and Bunge's *Theoretical Geography* (1962) appeared in the *Lund Studies in Geography*.
- **Cambridge, Britain: Richard J. Chorley** (geomorphology) and **Peter Haggett** (human geography) led the change in Britain.
  - Their edited volumes ***Frontiers in Geographical Teaching*** (1965) and ***Models in Geography*** (1967) were received as a declaration against idiographic regional geography.
- **Leading figures in brief:**
  - **Peter Haggett:** *Locational Analysis in Human Geography* (1965), *Network Analysis in Geography* (1969) and later work on the geography of epidemics.
  - **Richard Chorley** (1927–2002): replaced Davis's cycle with **general systems theory** in geomorphology ("Geomorphology and General Systems Theory", 1962).
  - **William Bunge** (1928–2013): *Theoretical Geography* (1962) declared **geometry the language of geography**. He later turned radical and led the **Detroit Geographical Expedition**.
  - **Torsten Hägerstrand** (1916–2004): **diffusion models** and, later, **time geography**.

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GEOGRAPHICAL THOUGHT · QUANTITATIVE REVOLUTION

Where the Quantitative Revolution Began

Six university centres in North America and Europe turned geography into a spatial science between the early 1950s and the late 1960s.



1 Washington, Seattle
William Garrison and Edward Ullman
Location and central place theory
Students: Berry, Bunge, Dacey, Marble, Morrill and Tobler

2 Iowa
Harold McCarty and Fred Schaefer
'Exceptionalism in Geography' (1953)
Laws of association between geographical patterns

3 Wisconsin, Madison
Weaver's crop combinations (1954)
Robinson's statistical cartography with climatologist Reid Bryson

4 Princeton
John Q. Stewart and William Warntz
Social physics: the gravity model and population potential ('macrogeography')

5 Lund, Sweden
Edgar Kant; Torsten Hägerstrand
Diffusion thesis (1953) and Monte Carlo simulation; Bunge's Theoretical Geography (1962) published here

6 Cambridge, Britain
Richard Chorley and Peter Haggett
Frontiers in Geographical Teaching (1965); Models in Geography (1967)
Systems and model-based paradigm

United States first
- Four centres in the 1950s
- Seattle the most productive; its students spread the new geography

Europe follows
- Lund: diffusion and theoretical geography
- Cambridge: models and the British 'new geography' of the 1960s

Shared toolkit
- Location theory, social physics, statistics
- Computers and the hypothetico-deductive method

Locations of the universities are exact; map panels are at different scales. Relief: NOAA ETOPO1.

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From Resistance to Acceptance

- Resistance was strongest in the United States, where the reaction against environmental determinism had been sharpest. Quantification looked like a return to mechanistic explanation. Yet the US soon became its strongest base.
- **Endorsements from the establishment:**
  - **Ackerman** (*Geography as a Fundamental Research Discipline*, 1958) urged regression, correlation and variance analysis because **"accurate study depends on quantification"**.
  - **Hartshorne** (1959) accepted that **generic concepts** and correlations are best handled through quantitative measurement and statistical comparison.
  - **O. H. K. Spate's** "Quantity and Quality in Geography" (1960) accepted the tools but warned against confusing **means with ends**.

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- **Burton's verdict (1963):** an intellectual revolution is over when its ideas become conventional wisdom. When Ackerman, Hartshorne and Spate broadly agreed on quantification, that point had been reached.
  - For Burton, **theory** was the revolution's real prize. Theory works as a sieve for sorting countless facts, and without it every event looks unique and no exception can even be recognised.
  - Quantification did not create the need for theory, but it supplied a technique for building and testing it.
- **Debates in the journals** gave the new methods visibility and legitimacy:
  - **Garrison and Nelson** argued over the classification of urban services.
  - **Reynolds and Garrison** argued over how far quantification should go.
  - **Zobler and Mackay** debated the **chi-square test** in regional geography.
  - **Spate and Berry** argued in *Economic Geography*; **Lukermann and Berry** argued over what makes economic geography "geographic".
- **Institutions:**
  - **Walter Isard** founded the **Regional Science Association (1954)**. It blended economics, geography and planning, and its *Journal of Regional Science* carried many classic quantitative papers.
  - The **National Academy of Sciences–National Research Council** report ***The Science of Geography*** (1965) named the **statistical and dynamic correlation of spatial distributions** as a key to understanding living, social and environmental systems.
    - It explained the slow start candidly: geographers were few, the problems many, multivariate methods demanding, and systems concepts only recently developed.
- **Doubters within the establishment:** Spate held that geographers trained as social scientists lacked the mathematical temperament the new methods demanded, and risked serious errors of judgement. **L. Dudley Stamp** opposed the uncritical borrowing of techniques and trusted the well-made map. Yet statistical methods soon **improved map-making** itself.

03 Methods, Approaches and Models

The Quantitative Toolkit

- **Statistical methods** test hypotheses against empirical data:
  - Descriptive statistics: mean, median, standard deviation and the coefficient of variation, for example of rainfall variability.
  - Inferential tests: the chi-square test, then **bivariate and multiple regression**, correlation, and in the 1960s the **general linear model**.
  - Data reduction: factor and principal-components analysis. Pattern measures: the nearest-neighbour index for settlement spacing.
  - Spatial statistics: spatial autocorrelation, trend surfaces and space-time forecasting.
- **Mathematical methods** derive models from abstract assumptions:
  - **Geometry** was Bunge's language of space.
  - **Graph theory** described networks, **matrix algebra** described flows between places, and **calculus** described optimisation over continuous space.

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- **Two sources of models:**
  - **Social physics** led to the **gravity model**: interaction varies with the product of the masses and inversely with distance. It also produced **population potential** and later **entropy-maximising** models (**Alan Wilson**, *Entropy in Urban and Regional Modelling*, 1970).
  - **Neoclassical economics**, through **regional science**, supplied **location theory**: von Thünen, **Weber**, **Christaller and Lösch**, and the work of Isard.
- **Computers** made it possible to handle large multivariate data sets. Model-building came first, but operational models could not have spread without them.
- **Waldo Tobler's** "first law of geography" (1970) stated that **everything is related to everything else, but near things are more related than distant things**. It became the founding principle of spatial analysis.

Three Approaches Within the Revolution

- **Locational analysis:** explains the spatial arrangement of human activity and seeks **optimal locations**.
  - **Peter Haggett** (1965) broke spatial structure into **movement, networks, nodes, hierarchies and surfaces**, and later added **diffusion**.
- **Spatial analysis or spatial science:** treats the earth as a geometry of points, lines and areas. It measures distance, direction, connectivity and pattern, and builds general theorems of **spatial organisation**.
  - Space was understood less as absolute space and more as relative space, measured in time, cost or connectivity.
- **Systems analysis:** studies elements, the links between them and their links with the environment.
  - **Ludwig von Bertalanffy's** general systems theory reached geography through **Chorley** (1962). Chorley and Kennedy's *Physical Geography: A Systems Approach* (1971) classified systems as **morphological, cascading, process–response and control** systems.
  - Feedback is either negative, which keeps a system steady, or positive, which drives it to change. Systems thinking promised a bridge between physical and human geography.

APPROACH	CORE QUESTION	KEY TOOLS	EXAMPLE
Locational analysis	Where should an activity be?	Location theory, cost surfaces	Weber's least-cost location
Spatial analysis	What pattern exists, and why?	Geometry, spatial statistics	Nearest-neighbour index of villages
Systems analysis	How do the parts interact over time?	Flows, feedback, simulation	Drainage basin or city region as an open system

Models and Model-Building

- A **model** is an **idealised, simplified and structured representation of reality**. It brings out selected relationships and suppresses incidental detail ("noise").
  - **Chorley and Haggett** (1967) treated a model as a theory, law, hypothesis or structured idea. A model becomes a theory only when it has been successfully tested against the real world.

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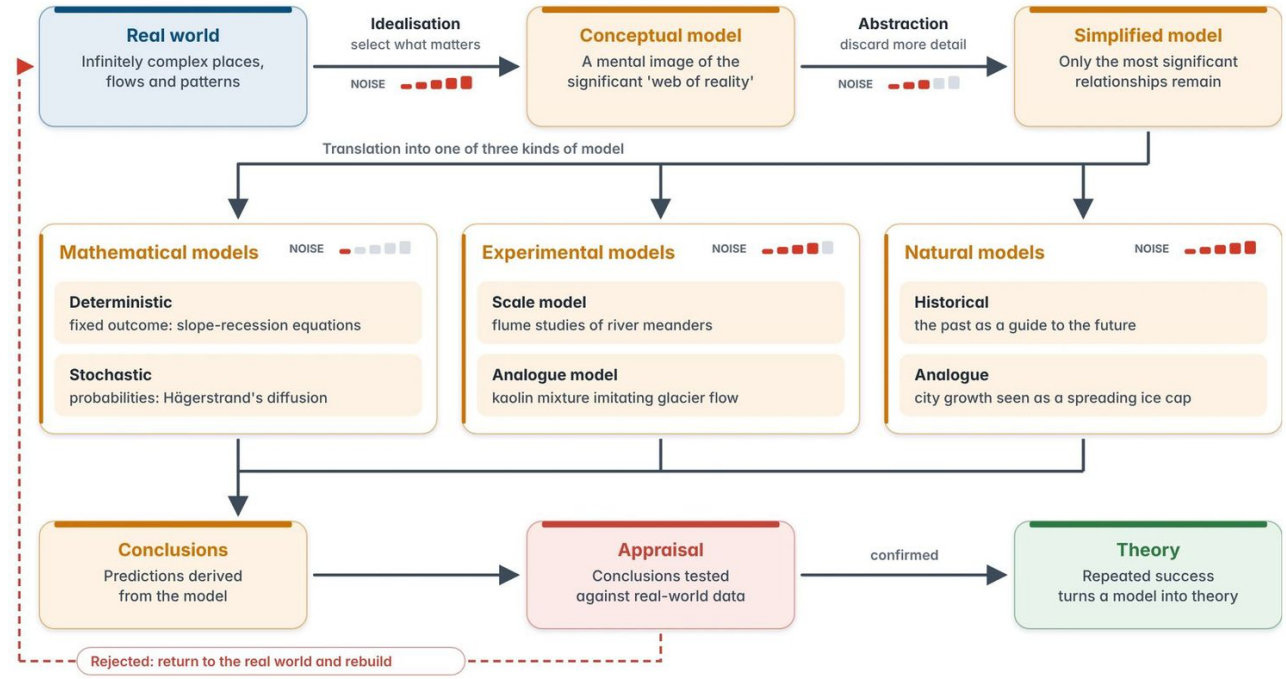
- **Analogue theory** underlies model-building. One system is studied through a simpler, more familiar analogue, such as trips between towns studied as gravitation, or a city treated as an ice cap spreading outward.
- **Chorley's sequence (1964):**
  - **Idealisation:** select the significant features of the real world.
  - **Conceptual model:** a mental picture of the "web of reality".
  - **Simplified model:** strip away remaining detail.
  - **Translation:** turn the simplified model into a mathematical, experimental or natural model.
  - **Conclusions** are derived and **tested against the real world**. Repeated successful tests yield a **theory**.
- **Types of model:**
  - **Mathematical**, which may be **deterministic** (fixed outcomes, such as slope-recession equations) or **stochastic** (probabilities, such as Hägerstrand's diffusion waves).
  - **Experimental**, which may be **scale models** (flume studies of meanders) or **analogue models** (kaolin mixtures used to model glacier flow).
  - **Natural**, which may be **historical analogues** (the past used to predict the future) or **analogues in another medium**.
- **What the revolution gave model-building:**
  - A method, the hypothetico-deductive test.
  - A language, mathematics and statistics.
  - A toolset, computers and sampling.
  - A purpose, general theorems of spatial organisation.
  - Chorley and Haggett framed this **"model-based paradigm"** in Thomas Kuhn's terms.
- **Classical models revived and extended:**
  - von Thünen's rings, Weber's location triangle and **Christaller–Lösch central places** became the "normal science" of the new paradigm.
  - Also revived were the **gravity model** and its retail form (**Reilly's law**, Converse's **breaking point**), the **rank-size rule**, **distance decay** and **diffusion**.
- **Indian applications:** crop-combination and agricultural efficiency regions, central-place hierarchies of market towns and service centres, gravity-based delimitation of city hinterlands, and growth-centre planning.

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GEOGRAPHICAL THOUGHT · QUANTITATIVE REVOLUTION · MODELS

How a Geographical Model Is Built

Chorley's sequence (1964): the real world is idealised and simplified, translated into a model, and the model's conclusions are tested until a theory emerges.



Noise

- Incidental detail lost or added at each step
- Mathematical translation is almost noise-free; natural analogues are the noisiest

Why the revolution mattered

- Hypothesis testing, statistics and computers gave models a method
- Models became the core of a 'model-based paradigm'

The limit

- A model is right or wrong on logic alone
- It becomes theory only after real-world tests

After R. J. Chorley's 'model for models' (1964); noise bars show relative loss of information. lotusarise.com

Impact on the Branches of Geography

- **Geomorphology:** this branch met the sharpest early clash.
  - **Robert E. Horton** (1945) had already given drainage basins quantitative laws. **Arthur N. Strahler** ("Dynamic Basis of Geomorphology", 1952) rejected **W. M. Davis's** descriptive cycle in favour of **G. K. Gilbert's** dynamic, process-based approach.
  - **S. W. Wooldridge** and others defended Davis and doubted "quasi-mathematical" geomorphology.
  - **Chorley, G. H. Dury, J. Ross Mackay and M. Gordon Wolman** carried process studies forward. By the 1970s quantitative process geomorphology was the mainstream.
- **Climatology:** this branch took to quantification readily.
  - **C. Warren Thornthwaite's** water-balance classification, its later development with **John R. Mather**, and **Reid Bryson's** statistical climatology made it a leading quantitative field.

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- **Human and economic geography:** this was the hardest ground.
  - The **possibilist** stress on free human choice seemed to rule out prediction. The answer was the statistical view of society: random behaviour among individuals, predictable order in the aggregate. Physics had made the same move for particles.
  - Urban geography (Berry's central place studies), economic and transport geography and regional science became the most quantified fields.
- **Population and diffusion:** Hägerstrand's models, Ravenstein-type migration laws and **gravity models of migration**.
- **Cartography:** classed choropleth and isopleth intervals were set statistically, and later automated in computer mapping.

BRANCH	RESPONSE	LEADING FIGURES	TYPICAL TOOLS
Geomorphology	Contested, then adopted	Horton, Strahler, Chorley	Stream order, hypsometry, process equations
Climatology	Readily adopted	Thornthwaite, Mather, Bryson	Water balance, statistical classification
Urban and economic	Initially resisted, then dominant	Garrison, Berry, Haggett	Central place, gravity, regression
Agricultural	Adopted	Weaver	Crop combination, deviation methods
Population and diffusion	Adopted	Hägerstrand, Morrill	Monte Carlo diffusion, migration models

The Revolution in Indian Geography

PYQ 2016 · 1990 · 1986

- Quantitative methods reached Indian university departments in the 1960s and 1970s, mostly through geographers trained in Britain and the United States.
  - Research moved from descriptive regional monographs to statistical analysis of Census and survey data: correlation and regression, factor and cluster analysis, and indices of concentration and disparity.
  - Regional boundaries were often made to match districts or tehsils, so that data could be measured and compared.
- **Fields that took up the new methods:**
  - **Agricultural geography:** crop-combination, crop-diversification and agricultural-efficiency regions.
  - **Population geography:** this grew at **Panjab University, Chandigarh**, from the 1960s, on the basis of Census data on growth, density, migration and sex ratio.
  - **Urban and regional planning:** settlement hierarchies, service centres and growth-centre strategies. **Moonis Raza**, founding head of the regional development centre at Jawaharlal Nehru University, tied geography to planning.

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- **A self-critique followed.** Indian geographers warned that formulae and symbols could become decoration that hides a lack of thought. Quantification sharpened measurement, but on its own it is not geography.

04 Evaluation and Legacy

Merits

- **Scientific status:** geography gained **theory, testable hypotheses and models**. Its findings could be verified and replicated.
- **Precision and economy:** mathematical statements are brief, exact and comparable.
  - Statistical classes made **choropleth and isopleth maps** objective. **Scatter diagrams and correlation** turned man–environment relations into measurable associations.
- **Handling complexity:** factor analysis and similar techniques reduce many variables to a few dimensions, which helps the study of socio-economic problems.
- **Pattern recognition: nearest-neighbour analysis** separates clustered, random and regular settlement patterns, which is useful for planning services.
- **Objective regionalisation:** statistical delimitation (crop-combination, functional and gravity-based regions) replaced judgement-based boundaries that overlapped or left gaps.
- **Applied value:** forecasting, simulation and site selection made geographers useful to planners, transport engineers and businesses.
- **Primary research:** field surveys, sampling and measurement let geographers produce **their own data** instead of relying on descriptions borrowed from other sciences.
- **Prediction:** models such as the gravity model and diffusion simulations allowed **forecasting**, from traffic flows to the spread of an innovation or an epidemic.
- **Unity:** systems thinking and shared methods narrowed the gap between physical and human geography.

Demerits

- **Criticism of quantification** came from philosophers, behaviouralists, humanists, radicals and feminists. Its main charges were these:
  - **Unreal assumptions:** isotropic plains, perfect knowledge and optimising "economic man" do not exist. **Herbert Simon's** "satisficing" decision-maker settles for a satisfactory option rather than the optimal one.
  - **Values excluded:** beliefs, customs and taboos shape resource use. Dairying is not traditional among the **Khasi** of Meghalaya or the **Mizo** of Mizoram, so a model that ignores culture misreads the landscape.
  - **Space geometry:** people became **points on a plane**, and geometry proved too **static** to explain processes unfolding in time.
  - **Western bias:** models built on a century of North American and West European data were treated as universal truths.

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  - **Data limits:** reliable data were scarce in developing countries, including **India** in the 1960s, and forecasts often failed.
  - **Means over ends:** technique for its own sake. **L. Dudley Stamp** (1966) mocked the computer as the movement's "golden calf".
  - **Mechanistic people:** decision-makers became passive agents responding to costs, which some critics called a new **economic determinism**.
  - **Rigid answers:** exact numerical results suited physics better than a social science, where conclusions need room for context and change.
  - **Politics:** locational efficiency was said to serve **capitalist** profit and to ignore inequality.
- These weaknesses fed the **behavioural**, humanistic and radical reactions of the 1970s, together called the **critical revolution**.

Legacy: From Spatial Science to GIScience

- **Lasting gains:** the revolution left theory-building, hypothesis testing, sampling and statistical literacy as permanent parts of geographical training.
  - Quantitative work continues in journals such as *Geographical Analysis*, *Environment and Planning A* and the *Journal of Geographical Systems*.
- **GIScience:** computers, remote sensing and **Geographic Information Systems** turned spatial analysis into a technology. **Michael F. Goodchild** (1992) named the field **geographical information science**.
  - Today it extends into spatial data science, big data and machine learning.
- **Local, not only global:** methods such as **geographically weighted regression** (A. Stewart Fotheringham and colleagues) model how relationships vary from place to place. They reverse the old search for universal laws.
- Uneven adoption: quantification took deepest root in transport, economic and urban geography, which had close ties with engineering and neoclassical economics. Cultural and historical geography stayed largely qualitative.
- **Critical quantification:** **Mei-Po Kwan** and **Tim Schwanen** (2009) described a "critical (re)turn". In it, numbers serve feminist, anti-racist and social-justice research, such as mapping gendered mobility or unequal exposure to pollution.
- **Indian examples:**
  - ISRO's **Bhuvan** geoportal and the **PM Gati Shakti National Master Plan** (2021) use GIS layers to plan infrastructure.
  - District-level Census and survey data support statistical regionalisation of crops, development and deprivation.
- **Recent directions:** studies now ask how gender, race, ethnicity, age and class shape movement, access and exposure, using fine-grained local data. Quantitative evidence is also used to challenge unjust policies as well as to describe patterns.
- **Balance:** most geographers now mix methods. They count what can be counted and interpret what cannot. By the end of the 1960s spatial science, launched mainly in North America, dominated the leading English-language journals. Its models gave only a partial picture of the man–environment relationship, yet the quantitative revolution remains the base on which modern spatial analysis stands.

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Previous Year Questions

2022	Critically examine the significance of the Quantitative Revolution and its influence in the development of Geography.
2018	Discuss critically the manner in which quantitative revolution provided the methodological foundation for models and modeling in geography.
2016	Trace the origin and progress of Quantitative Revolution in Geography and bring out its merits and demerits.
2009	'Quantitative Revolution and model building provided an empirical basis for geographical research' – Elaborate.
1998	What is understood by quantification in Geography? Discuss the significance of quantification in modern geographical studies with examples.
1990	Write short note on Quantitative and behavioural revolutions in geography.
1986	What is meant by 'quantitative revolution in geography'? Discuss its impact on the development of the subject.

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