

Introduction to Geodatabases

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Key concepts, components, and best practices

1. What Is a Geodatabase?

Aspect	Description
Definition	A spatial database designed to store, query, and manage geographic data and its attributes.
Purpose	Provides a framework for organizing, editing, and analyzing spatial information in a consistent, scalable way.
Typical Use? Cases	Urban planning, environmental monitoring, utilities management, transportation routing, disaster response, location-based services.

2. Types of Geodatabases

Type	Storage Model	Typical Platform	Strengths
File Geodatabase	Folder of files (.gdb)	Desktop GIS (ArcGIS, QGIS)	Simple deployment, up to 1 TB per dataset, fast read/write for single user or small teams.
Personal Geodatabase	Microsoft Access (.mdb)	Desktop GIS (ArcGIS)	Easy to create, limited to 2 GB, Windows-only.
Enterprise (ArcSDE) Geodatabase	RDBMS (SQL Server, Oracle, PostgreSQL/PostGIS, IBM DB2)	Server-based GIS, web services	Multi-user editing, versioning, advanced security, scalability to billions of features.
Spatialite / GeoPackage	SQLite file format	Open-source GIS, mobile apps	Cross-platform, lightweight, OGC-standard, supports raster and vector.

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Type	Storage Model	Typical Platform	Strengths
NoSQL / Cloud-native	Document/Key-Value stores (e.g., MongoDB, DynamoDB) + spatial extensions	Cloud GIS, big-data analytics	Horizontal scaling, flexible schema, integration with big-data pipelines.

3. Core Data Model Elements

Element	Explanation	Example
Feature Class	Collection of homogeneous features (same geometry type & attributes).	Roads (polyline), Buildings (polygon).
Raster Dataset	Grid of cells storing imagery, elevation, or other continuous data.	Satellite image, DEM.
Table	Non-spatial attribute data that can be related to features.	Asset inventory, survey results.
Relationship Class	Defines logical links (one-to-one, one-to-many, many-to-many) between tables/feature classes.	Parcels ? Owners.
Topology	Set of rules governing spatial relationships (e.g., no gaps, no overlaps).	Ensuring land parcels share boundaries without gaps.
Network Dataset	Model for routing, flow, and connectivity analysis.	Road network for shortest-path calculations.
Geometric Network	Supports utility network modeling (flow direction, connectivity).	Water distribution system.
Annotation & Labels	Stored text tied to geographic locations.	Street names, property numbers.
Domains & Subtypes	Attribute validation mechanisms (coded values, ranges).	Land-use codes, building type categories.

4. Data Organization & Structure

1. Datasets (Containers)

- *Feature Datasets*: Group related feature classes that share a common coordinate system and spatial extent.

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- *Raster Datasets*: Stored individually or within raster catalogs.

2. Spatial Reference

- Every dataset has a defined coordinate system (projected or geographic) and datum.
- Consistency avoids projection errors during analysis.

3. Versioning (Enterprise)

- **Default Version** – the master copy.
- ****Child**