Training Course on GIS for Hydrology and Water Resource Management

Professional Development Training Course Outline

Category	GIS	**Duration**	10 Days
Base Fee	$3,000 USD	**Delivery Mode**	Online / On-site Hybrid

Course Introduction

In an era of unprecedented climate change and increasing water scarcity, effective water resource management has become paramount for global sustainability. Geographic Information Systems (GIS) offer a transformative suite of tools for **spatial data analysis**, **hydrological modeling**, and **environmental monitoring**, providing critical insights for informed decision-making in the water sector. This intensive training course delves into the cutting-edge applications of GIS, empowering professionals to leverage geospatial technologies for **watershed management**, **flood risk assessment**, **groundwater analysis**, and **water quality monitoring**, ensuring resilient and sustainable water systems.

Training Course on GIS for Hydrology and Water Resource Management is designed to bridge the gap between theoretical understanding and practical application, equipping participants with the skills to tackle complex water challenges. Through hands-on exercises, real-world case studies, and expert-led instruction, attendees will master **GIS software (ArcGIS/QGIS)**, **remote sensing data integration**, and **spatial modeling techniques**. The course emphasizes **data-driven solutions** for **integrated water resource management (IWRM)**, fostering a holistic approach to address the intricate interdependencies within hydrological systems and ultimately contributing to **water security** and **climate resilience**.

Programme Curriculum

Training Course on GIS for Hydrology and Water Resource Management

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Course Duration

10 days

Course Objectives

1. Proficiently collect, process, and manage diverse **geospatial data** for water resource applications, including **satellite imagery**, **DEMs (Digital Elevation Models)**, and **field survey data**.
2. Apply GIS techniques for accurate **watershed delineation**, **drainage network extraction**, and **catchment characterization** using **high-resolution topography**.
3. Utilize GIS for **rainfall-runoff modeling**, **flood inundation mapping**, and **hydrological forecasting** to understand water flow dynamics.
4. Leverage **remote sensing** data (e.g., **Sentinel-2**, **Landsat**) for **water body detection**, **drought monitoring**, **flood mapping**, and **water quality assessment**.
5. Map **groundwater potential zones**, assess **aquifer vulnerability**, and monitor **groundwater levels** and **recharge areas** using spatial analysis.
6. Employ GIS to map **pollution sources**, analyze **water quality parameters**, and identify **contamination hotspots** for effective mitigation strategies.
7. Build and apply GIS models for **flood hazard mapping**, **vulnerability assessment**, and **early warning systems** to enhance disaster preparedness.
8. Utilize GIS for **drought severity mapping**, **water balance analysis**, and identifying areas for **water conservation initiatives**.
9. Map and analyze **water supply networks**, **irrigation schemes**, and **wastewater treatment facilities** for efficient planning and management.
10. Integrate **climate model projections** with GIS to assess the impacts of climate change on water resources and inform **adaptation strategies**.
11. Apply **MCDA** within a GIS framework for **optimal site selection** (e.g., dam construction, groundwater abstraction) and **resource allocation**.
12. Create and share **web maps**, **dashboards**, and **story maps** to communicate water-related information to diverse stakeholders.
13. Gain proficiency in **QGIS** and other **open-source geospatial software** for cost-effective and flexible water resource management solutions.

Organizational Benefits

- Leverage spatial insights for more informed and data-driven decisions in water resource planning and management.
- Optimize water infrastructure, reduce operational costs, and streamline workflows through GIS automation.

- Better anticipate and mitigate risks associated with floods, droughts, and water quality degradation.
- Promote environmentally sound practices and contribute to long-term water security.
- Facilitate better communication and collaboration among government agencies, communities, and NGOs through shared spatial data.
- Develop in-house expertise in cutting-edge geospatial technologies for sustained organizational growth.
- Generate accurate maps and reports for regulatory compliance and transparent reporting to stakeholders.
- Foster an environment of innovation by enabling advanced spatial analysis and research in water science.

Target Audience

1. Hydrologists & Water Resource Engineers.
2. Environmental Scientists & Ecologists
3. Urban & Regional Planners
4. Geospatial Analysts & GIS Specialists.
5. Agricultural Engineers & Land Managers.
6. Disaster Management & Emergency Response Teams
7. Government Officials & Policy Makers
8. Researchers & Academics.

Course Outline

Module 1: Foundations of GIS for Water Resources

- Introduction to GIS concepts: vector and raster data models, spatial data types.
- Understanding coordinate systems, projections, and georeferencing for water data.
- Overview of GIS software (ArcGIS Pro/QGIS) interface and core functionalities.
- Data acquisition methods: GPS, surveying, open data sources, web services.
- **Case Study:** Setting up a regional water basin project in GIS, importing diverse topographical and hydrological datasets.

Module 2: Essential Spatial Data Management & Visualization

- Organizing and managing water-related databases
- Data cleaning, validation, and quality control for accurate analysis.
- Symbology, labeling, and map layout design for compelling water maps.
- Creating charts, graphs, and reports to visualize spatial patterns.
- **Case Study:** Visualizing groundwater well locations, depths, and chemical parameters for a municipal water supply.

Module 3: Terrain Analysis for Hydrological Applications

- Digital Elevation Models (DEMs): sources, resolution, and applications.
- Deriving fundamental hydrological parameters: slope, aspect, flow direction, flow accumulation.
- Identifying depressions (sinks) and creating hydrologically correct DEMs.
- Stream network extraction and stream ordering
- **Case Study:** Delineating sub-watersheds for a proposed dam construction site and analyzing their topographic characteristics.

Module 4: Watershed Delineation and Characterization

- Automated watershed delineation using GIS tools.
- Defining pour points and outlets for catchment areas.
- Calculating watershed characteristics: area, perimeter, shape factors, land cover.
- Analyzing sub-basins and their hierarchical relationships.
- **Case Study:** Delineating the catchment area for a drinking water reservoir and assessing land use within its boundaries for potential pollution risks.

Module 5: Remote Sensing for Water Body Monitoring

- Introduction to remote sensing principles and satellite imagery for water.
- Spectral indices for water detection: NDWI, MNDWI, AWEI.
- Monitoring changes in water body extent over time (e.g., lake levels, reservoir capacity).
- Mapping wetlands and riparian zones using satellite data.
- **Case Study:** Using time-series Landsat imagery to monitor the shrinkage of a significant lake due to climate change and human abstraction.

Module 6: Hydrological Modeling I: Rainfall-Runoff & Flow Paths

- Concepts of rainfall-runoff processes and contributing factors.
- Introduction to distributed and lumped hydrological models in GIS.
- Using curve number (CN) method for runoff estimation.
- Mapping flow paths and overland flow accumulation areas.
- **Case Study:** Simulating runoff generation from a watershed under different rainfall scenarios for urban stormwater management planning.

Module 7: Hydrological Modeling II: Flood Risk Assessment

- Floodplain mapping using DEMs and hydrological models.
- Identifying flood-prone areas and estimating flood depths.
- Integrating historical flood event data for calibration.
- Assessing infrastructure and population vulnerability to flooding.
- **Case Study:** Developing a flood hazard map for a coastal city, identifying critical infrastructure at risk from sea-level rise and storm surges.

Module 8: Groundwater Mapping and Analysis

- Mapping groundwater wells, boreholes, and observation points.
- Interpolation techniques for creating potentiometric surface maps.
- Identifying groundwater flow directions and gradients.
- Mapping aquifer boundaries and recharge/discharge zones.
- **Case Study:** Analyzing groundwater levels across an agricultural region to identify areas of over-abstraction and potential saltwater intrusion.

Module 9: Water Quality Mapping and Monitoring

- Importing and visualizing water quality sampling data.
- Spatial interpolation of water quality parameters.
- Mapping pollution sources and their spatial impact.
- Hotspot analysis for identifying areas with elevated contaminant concentrations.
- **Case Study:** Mapping nitrate contamination in a rural watershed, correlating with agricultural land use and identifying vulnerable groundwater sources.

Module 10: GIS for Irrigation and Agricultural Water Management

- Mapping irrigated areas and assessing crop water requirements.

- Suitability analysis for new irrigation schemes based on soil, topography, and water availability.
- Monitoring crop health and water stress using remote sensing.
- Optimizing irrigation scheduling using spatial data.
- **Case Study:** Identifying optimal locations for new irrigation pivots in a semi-arid region to maximize agricultural productivity with minimal water use.

Module 11: Integrated Water Resource Management (IWRM) Applications

- Concepts of IWRM and the role of GIS in integrated planning.
- Multi-criteria decision analysis (MCDA) for water resource allocation.
- Stakeholder analysis and participatory GIS (PGIS) for community engagement.
- Conflict resolution and trade-off analysis in water management.
- **Case Study:** Using GIS to facilitate a participatory planning process for water allocation among competing users in a stressed river basin.

Module 12: GIS for Water Infrastructure and Network Analysis

- Digitizing and managing water distribution networks.
- Network analysis: tracing flow, identifying critical points, simulating breaks.
- Mapping wastewater collection systems and treatment plants.
- Asset management and maintenance planning using GIS.
- **Case Study:** Optimizing a city's water supply network to minimize pressure loss and identify areas prone to pipe bursts using network analysis tools.

Module 13: Climate Change and Water Resources with GIS

- Integrating climate model projections into GIS.
- Assessing the impact of climate change on water availability and extreme events.
- Mapping areas vulnerable to climate-induced water stress.
- Developing GIS-based adaptation strategies
- **Case Study:** Analyzing the projected impact of climate change on glacier melt and its effect on downstream river flow and water supply for a mountain community.

Module 14: Web GIS and Data Sharing for Water Management

- Introduction to Web GIS platforms
- Publishing and sharing water-related maps and data online.
- Creating interactive web applications and dashboards for public engagement.
- Mobile GIS for field data collection and real-time monitoring.
- **Case Study:** Developing a public-facing web map displaying real-time river levels and flood alerts for a vulnerable community.

Module 15: Advanced Topics & Future Trends in Water GIS

- Introduction to scripting for GIS automation
- Big data analytics and cloud computing for large hydrological datasets.
- Integration of Artificial Intelligence (AI) and Machine Learning (ML) in water modeling.
- LiDAR data applications for detailed topographic and hydrological analysis.
- **Case Study:** Automating a watershed-wide erosion assessment process using Python scripting and integrating with a soil loss model.

Training Methodology

- **Instructor-Led Presentations:** Clear and concise theoretical explanations of GIS concepts and their application in hydrology.
- **Hands-on Practical Exercises:** Extensive guided lab sessions using ArcGIS Pro and QGIS, working with real-world water datasets.
- **Real-World Case Studies:** In-depth analysis and discussion of successful GIS applications in hydrology and water resource management from around the globe.
- **Project-Based Learning:** Participants will work on a capstone project applying learned skills to a relevant water problem.
- **Interactive Discussions & Q&A:** Fostering a collaborative learning environment for sharing experiences and problem-solving.
- **Demonstrations & Software Walkthroughs:** Step-by-step guidance on using various GIS tools and functionalities.
- **Group Work & Peer Feedback:** Encouraging teamwork and diversified perspectives on challenges.
- **Take-Home Resources:** Providing comprehensive course manuals, datasets, and useful links for continued learning.

Register as a group from 3 participants for a Discount

Send us an email: info@fineskilltrainingcenter.org or call *+254769199797*

Certification

Upon successful completion of this training, participants will be issued with a globally- recognized certificate.

Tailor-Made Course

We also offer tailor-made courses based on your needs.

Key Notes

a. The participant must be conversant with English.

b. Upon completion of training the participant will be issued with an Authorized Training Certificate

c. Course duration is flexible and the contents can be modified to fit any number of days.

d.

Upcoming Scheduled Sessions

Start Date	End Date	Location	Price

23 Nov 2026	04 Dec 2026	Online	$2,000
23 Nov 2026	04 Dec 2026	Physical	$3,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$6,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$9,000
23 Nov 2026	04 Dec 2026	Physical	$12,000
23 Nov 2026	04 Dec 2026	Physical	$12,000

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