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**XIX WORLD WATER CONGRESS**  
International Water Resources Association (IWRA)  
Marrakech, Morocco | 1-5 December 2025

Kingdom of Morocco



Ministry of  
Equipment and Water

# Fast Dam Sitting An Innovative Tool for Identifying Small Dam Sites in Morocco

ABOUSSALEH ABDELHALIM

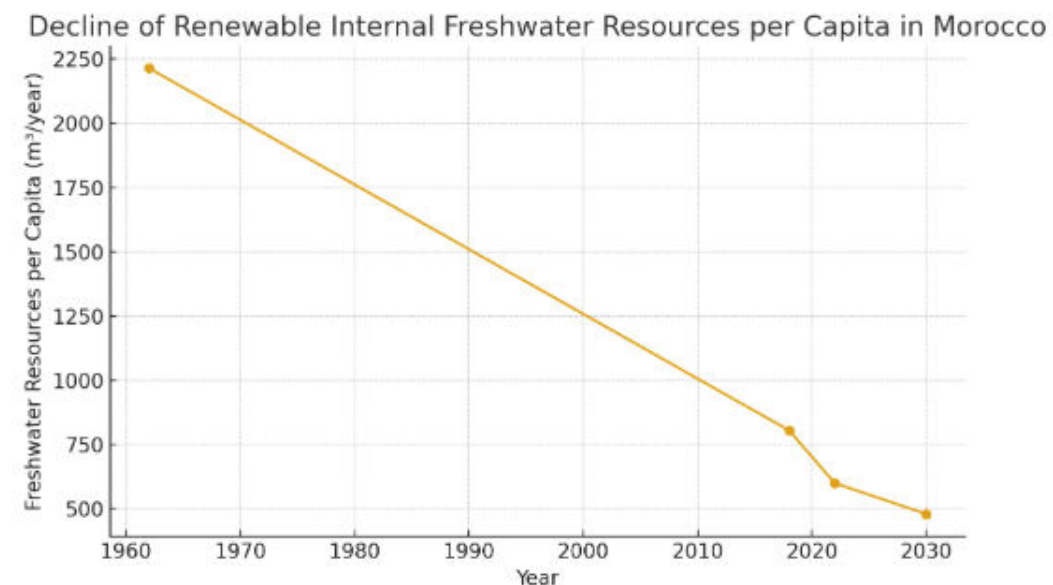
Geosciences, Geomatics and Environment Laboratory, Faculty of Sciences Ben M'Sick,  
University Hassan II, Casablanca, Morocco  
1-5 December 2025



# Context & Problem Statement

## The Growing Water Crisis in Morocco

- **Increasing Water Scarcity:** amplified by climate change and pressures from population growth and urbanization.
- **The Core Challenge:** A critical need to increase water storage capacity.
- **A Promising Solution:** Small dams offer a practical way to improve water access, especially in arid regions.
- **The Current challenge:** classical site selection methods are **slow, expensive, and not totally efficient.**



# Research Objective

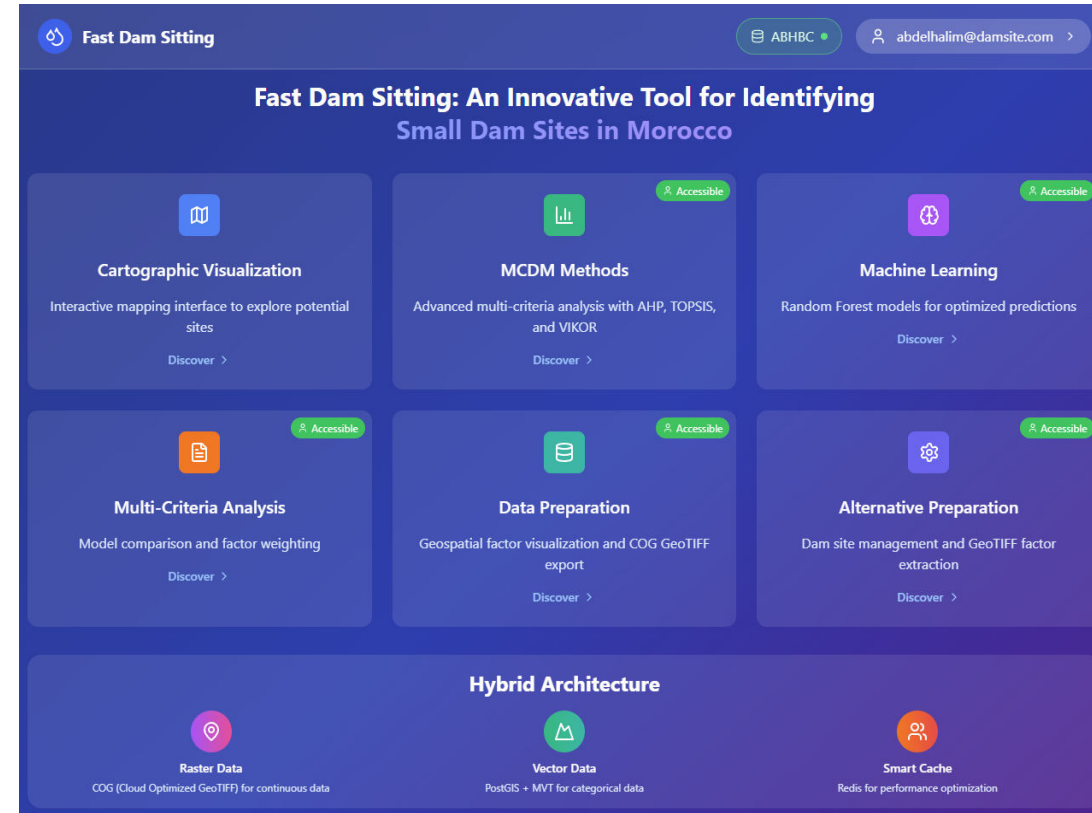
Develop an automated tool **Fast Dam Sitting** to:

- Rapidly identify optimal small dam sites
- Support proactive water resource planning
- Increase hydrological resilience under climate pressure

This approach Combines GIS, MCDM, and AI for decision support.



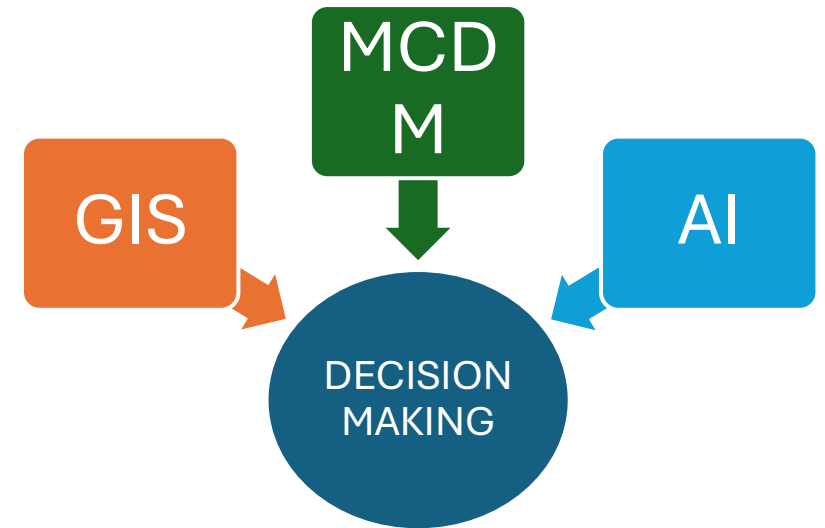
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# Methodology : An Integrated Approach

**A Powerful Triangulation of Methods :** The tool integrates three powerful components:

- **Geographic Information System (GIS)**  
For advanced geospatial data processing.
- **Multi-Criteria Decision Making (MCDM)**  
For structured evaluation and weighting of factors.
- **Artificial Intelligence (AI) Algorithms**  
For sophisticated optimization and pattern recognition.



# Methodology : Technical architecture



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## Modern Technology Stack:

### Frontend :

- React.js + TypeScript + Leaflet.js (web mapping)
- Tailwind CSS for responsive design

### Backend:

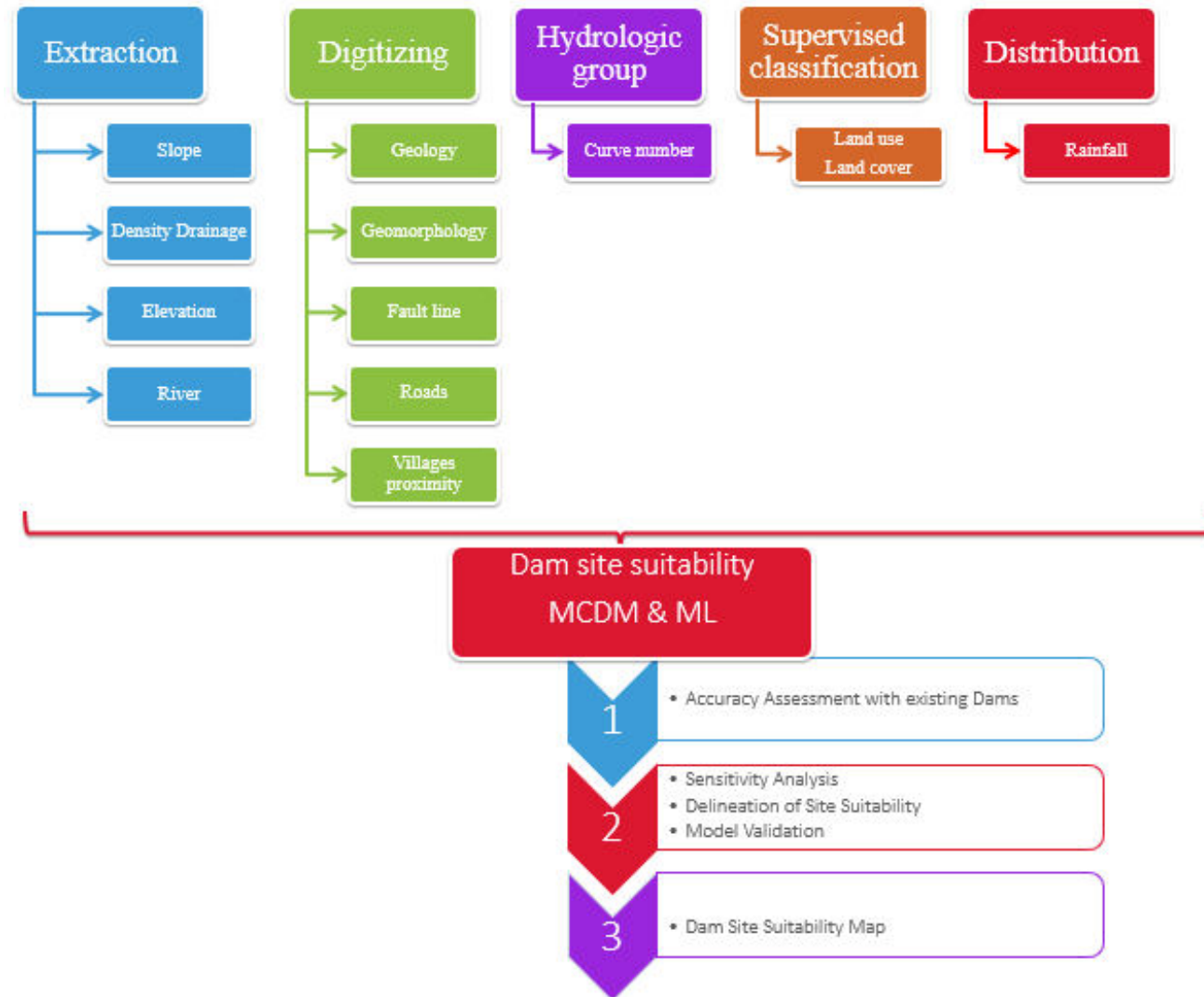
- FastAPI (Python) for REST APIs
- PostgreSQL for geospatial database
- Cloud Optimized GeoTIFF for geographic raster data

### Artificial Intelligence:

- Random Forest for machine learning
- Multi-Criteria Decision Making (MCDM) with AHP, MIF
- Automatic data normalization



# Methodology: Flowchart of decision framework



# Technical Evaluation



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## Refinement Stage:

- Preliminary dam design: storage volume, dam height & length
- Hydrological validation: runoff potential, catchment yield
- Feasibility assessment: environmental & socio-economic factors

Result: Data-driven and technically robust site prioritization.





## A- Live demonstration (if possible):

Our Fast Dam Siting Application is hosted on our server and requires only an internet connection.

## B- Continue with screen shots



# Principal page



**Fast Dam Sitting** ABHBC abdelhalim@damsite.com

## Fast Dam Sitting: An Innovative Tool for Identifying Small Dam Sites in Morocco

- Cartographic Visualization**  
Interactive mapping interface to explore potential sites  
[Discover >](#)
- MCDM Methods** Accessible  
Advanced multi-criteria analysis with AHP, TOPSIS, and VIKOR  
[Discover >](#)
- Machine Learning** Accessible  
Random Forest models for optimized predictions  
[Discover >](#)
- Multi-Criteria Analysis** Accessible  
Model comparison and factor weighting  
[Discover >](#)
- Factors Configuration** Accessible  
Configure factors classes, rankings and export COG GeoTIFF  
[Discover >](#)
- Dams sites classification** Accessible  
Dam site management and GeoTIFF factor extraction  
[Discover >](#)
- Dynamic Factors** Accessible  
Calculate watershed area and dam characteristics automatically  
[Discover >](#)

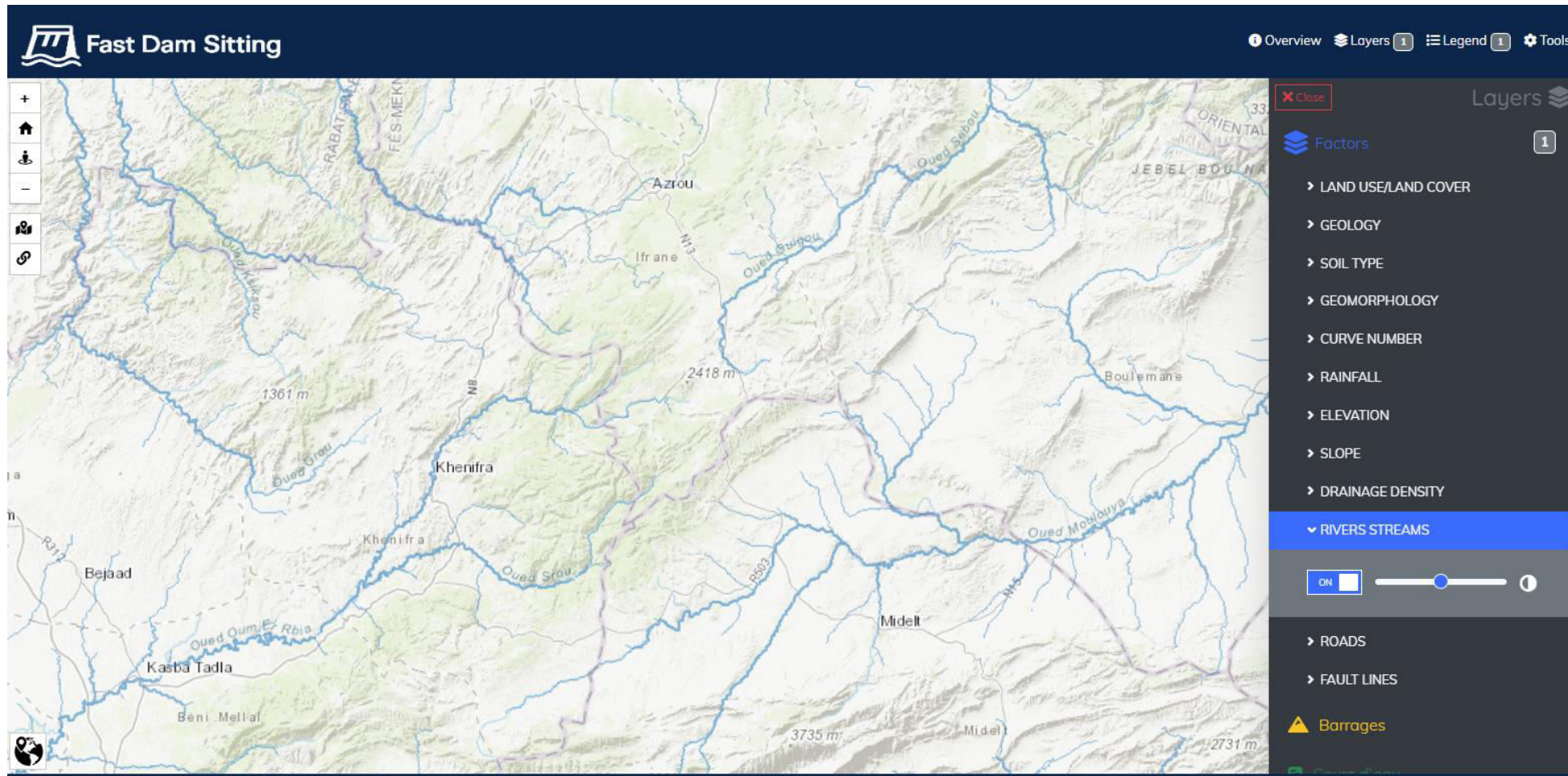
### Hybrid Architecture

- Raster Data**  
COG (Cloud Optimized GeoTIFF) for continuous data
- Vector Data**  
PostGIS + MVT for categorical data
- Smart Cache**  
Redis for performance optimization





# Geographic visualization



# MCDM Module



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## Résultats - AHP Classique

← Retour à l'analyse

Fermer

### Résumé de l'analyse

Méthode utilisée  
AHP Classique

Facteurs analysés  
9 facteurs

Statut  
Cohérent

### Poids des facteurs

Sauvegarder

Précipitations (mm/an)	23.3%
Pente (degrés)	18.8%
Densité de drainage (km/km <sup>2</sup> )	13.0%
Curve Number (CN)	7.1%
Distance aux rivières (m)	7.1%
Lignes de faille (m)	7.1%
Géologie	6.7%
Géomorphologie	7.1%
Altitude (m)	9.8%

### Vérification de cohérence

Ratio de cohérence (CR)

**0.028**

Acceptable ( $\leq 0.10$ )

Recommandation

La matrice de comparaison est cohérente. Les résultats sont fiables.

### Actions

Sauvegarder la configuration

Exporter les résultats

Générer rapport PDF

Générer carte de suitabilité



# Machine Learning Module



Machine Learning - Random Forest
×

Modèle d'apprentissage automatique pour la sélection optimale de sites de barrages

Configuration

Données

Entraînement

Résultats

**Résultats de l'Entraînement**

Le modèle a été entraîné avec succès. Voici les métriques de performance.

66.7%

Exactitude

55.6%

Précision

66.7%

Rappel

59.3%

F1-Score

**Sites Étudiés - Évaluation de Suitabilité** 18 sites Sauvegarder

Nom du Site	Longitude	Latitude	Suitabilité	Probabilité
b1	-6.8373	33.8821	● Moderate Suitable	43.9%
b2	-6.8214	33.8639	● Less Suitable	34.5%
b3	-6.8143	33.8468	● Less Suitable	39.5%
b4	-6.9890	33.8403	● Less Suitable	39.4%
b5	-6.9658	33.8219	● Less Suitable	30.5%
b6	-7.0495	33.7732	● Moderate Suitable	59.5%
b7	-7.0429	33.7712	● Suitable	65.8%
b8	-6.5795	33.8504	● Moderate Suitable	54.3%
b9	-6.2220	33.7741	● Less Suitable	39.1%



# Factors configuration Module



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### Configuration des Facteurs Éditable

Facteurs & Configuration

**Facteurs Disponibles (13 facteurs)**

- Curve Number (CN) (5 classes)
- Précipitations (mm/an) (5 classes)
- Géologie (35 classes)
- Proximité aux villages (m) (5 classes)
- Lignes de faille (m) (5 classes)
- Occupation du sol / Couverture terrestre (9 classes)
- Type de sol (14 classes)
- Densité de drainage (km/km<sup>2</sup>) (5 classes)
- Altitude (m) (5 classes)
- Distance aux rivières (m) (5 classes)
- Pente (degrés) (5 classes)
- Distance aux routes (m) (5 classes)
- Géomorphologie (7 classes)

Aucune légende disponible

**Informations Techniques**

Numéro de courbe SCS pour l'estimation du ruissellement  
Source non spécifiée

CLASSES PAR APTITUDE Modifier

5	Très haute	Tres élevé	Plages de valeurs: >80
4	Haute	Elevé	Plages de valeurs: 60 - 80
3	Modérée	moyen	Plages de valeurs: 50 - 60



# Factors configuration Module



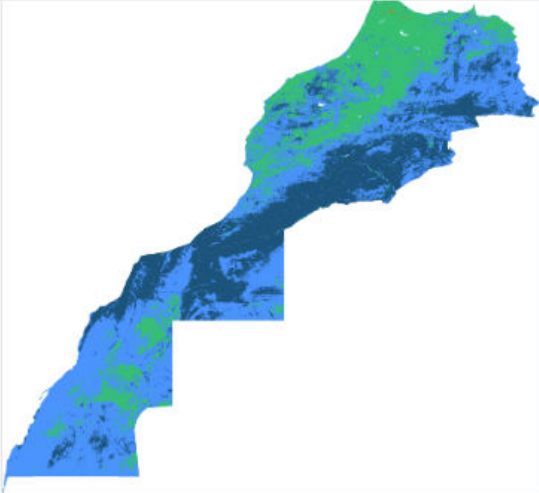
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# Dam site classification module



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**Topographie**

Altitude (m)

Pente (degrés)

**Géologie**

Lignes de faille (m)

Source des poids Changer

Configuration AHP (0 facteurs)

**Méthode de classement**

- Calcul des solutions idéales
- Distance euclidienne
- Coefficient de proximité
- Utilise les alternatives extraites

Distance aux rivières (m)	0.077	7.7%
Pente (degrés)	0.240	24.0%
Distance aux routes (m)	0.077	7.7%
Géomorphologie	0.160	16.0%

[Normaliser les poids](#)

**Alternatives (6)**

Alternative	Curve Number	Précipitations (mm/an)	Géologie	Proximité aux	Lignes de	Occupation du	Type de	Densité de	Altitude (m)	Distance aux	Pente (degrés)	Distance aux	Géomorphologie
EL MALEH AMONT	5.0	5.0	5.00	5.0	5.0	1.00	5.00	3.0	5.0	5.0	5.0	5.0	4.00
GAZELLE AVAL	5.0	5.0	5.00	5.0	5.0	5.00	5.00	3.0	5.0	5.0	4.0	5.0	2.00
GHZALA AMONT	5.0	5.0	5.00	5.0	5.0	5.00	5.00	3.0	5.0	5.0	5.0	5.0	2.00
ROUIDATE	3.0	5.0	5.00	5.0	5.0	1.00	5.00	3.0	5.0	5.0	5.0	3.0	5.00
TAMEDROUST	5.0	5.0	5.00	5.0	5.0	5.00	5.00	3.0	5.0	3.0	1.0	5.0	5.00
ARID	3.0	5.0	5.00	5.0	5.0	5.00	5.00	3.0	5.0	5.0	2.0	5.0	5.00

[Exécuter TOPSIS Classique](#)

**Résultats - TOPSIS Classique** [Sauvegarder](#) [Exporter](#)

Classement des alternatives :

Rang	Alternative	Score	Performance
<b>1</b>	TAMEDROUST	0.9063	<div style="width: 90.6%;"></div>
<b>2</b>	GAZELLE AVAL	0.6159	<div style="width: 61.6%;"></div>
<b>3</b>	ARID	0.3486	<div style="width: 34.9%;"></div>
4	ROUIDATE	0.2433	<div style="width: 24.3%;"></div>
5	EL MALEH AMONT	0.1738	<div style="width: 17.4%;"></div>
6	GHZALA AMONT	0.1150	<div style="width: 11.5%;"></div>

Visualisation des scores :

TAMEDROUST	<div style="width: 90.6%;"></div>	90.6%	#1
GAZELLE AVAL	<div style="width: 61.6%;"></div>	61.6%	#2
ARID	<div style="width: 34.9%;"></div>	34.9%	#3



# Dynamic factors module



## Dynamic Factors Calculator

← Retour

### Sites de barrages (6)

Ajouter manuellement Importer CSV Exporter CSV

EL MALEH AMONT	-7.34254351	33.50551887	
GAZELLE AVAL	-7.24221961	33.71272309	
GHZALA AMONT	-7.24558813	33.71838084	
ROUIDATE	-6.96761453	33.73342322	

### Facteurs dynamiques

Délimitation des BV

Axes de barrage interactifs (Tous modifiables)

Profils en travers (Extraction élévation)

Volume de la retenue

Hauteur de barrage

Longueur du barrage

Apport en eau

▶ Calculer tout

Afficher dans la carte

### Carte interactive

Couches géographiques:

Bassins versants  Réseau hydrographique



### Résultats de l'analyse

ID	Nom du site	Longitude	Latitude	Superficie (km <sup>2</sup> )	Volume retenue max (m <sup>3</sup> )	Largeur (m)	Hauteur (m)	Apport d'eau (m <sup>3</sup> /s)
1	EL MALEH AMONT	-7.342544	33.505519	1960.00	-	-	-	-
2	GAZELLE AVAL	-7.242220	33.712723	46.90	-	-	-	-





# Conclusions & Perspectives

- **A Significant Advancement:** "Fast Dam Sitting" represents an innovative, data-driven decision-support system for hydro-infrastructure planning.
- **Climate Adaptation:** The tool is perfectly aligned with the need for **decentralized** water storage solutions.
- **Proven & Adaptable:** The framework's demonstrated efficacy and inherent flexibility suggest **considerable potential for application in other water-stressed regions globally.**
- **Final Message:** A direct contribution to sustainable water resource management under increasing environmental uncertainty.
- **Next Steps:** Integration with real-time hydrological datasets; policy and planning adoption.



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Thank you!

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