الجمهوريـــــة الجزائريـــــة الديمقراطيـــــة الشعبيـــة

People's Democratic Republic of Algeria

وزارة الداخلية والجماعات المحلية و النقل

MINISTRY OF THE INTERIOR, LOCAL AUTHORITIES AND TRANSPORTS

*National Delegation for Major Risks*

المندوبية الوطنية للأخطار الكبرى

**Third Edition**

**RISK MANAGEMENT**

**Knowledge, Forecasting, Prevention, Protection, Planning, Preparedness**

**20 - 27 July 2025**

# Landslide Hazards in Algeria: Disaster Experience and Risk Reduction Strategies : From Geological Hazard to Urban Resilience

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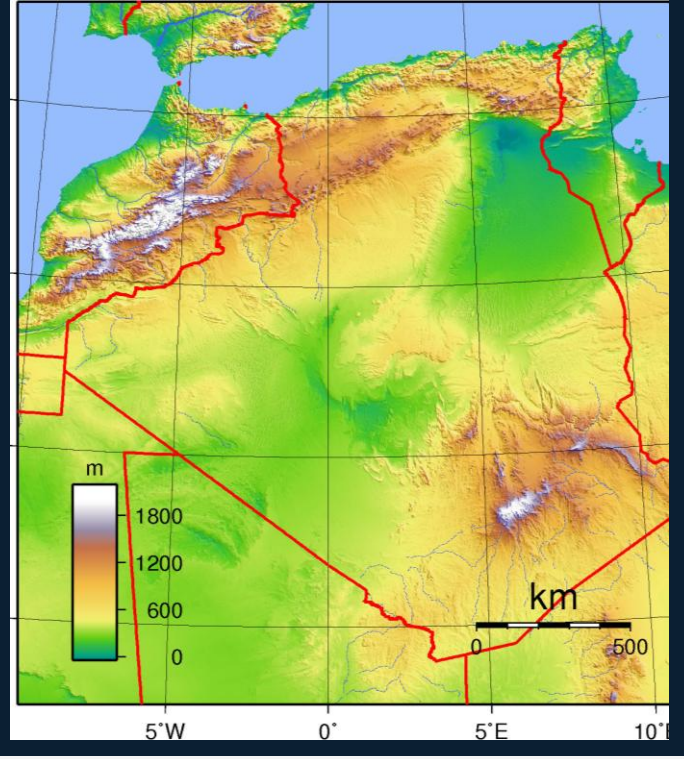
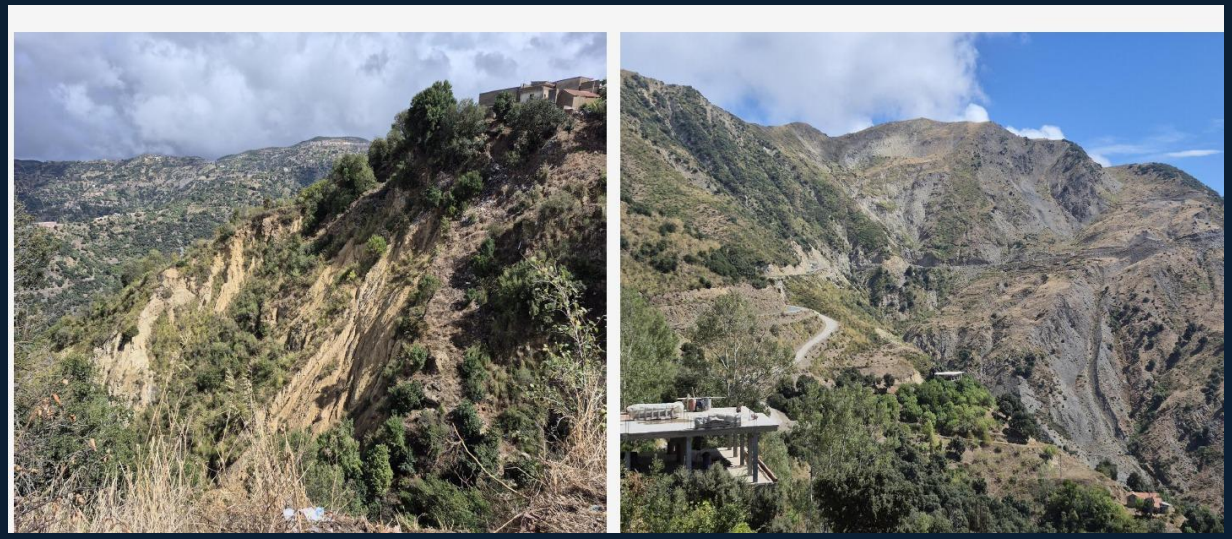
**Director of studies / Natural Risks Division**
**NDMR**

ALGERIA LANDSLIDE RISK

# From Geological Hazard to Urban Resilience

A modern problem statement built from the ASGA susceptibility mapping communication, the Télemly case study and the Wilaya of Oran crisis experience.
Risk knowledge, susceptibility mapping, monitoring, early warning and resilience for slope instability in northern Algeria.



**2.38M km²**

national territory with sharply contrasting geological and climatic environments

**North**

main concentration of landslide risk and exposed urban systems

NATIONAL CONTEXT

# A diverse territory, one exposed northern belt

Algeria extends from the Tellian Atlas and coastal urban corridors to the High Plateaus and Saharan margins. The landslide challenge is most intense in the north.

**18**
northern wilayas already mapped in the ASGA project

**4**
additional wilayas under mapping

**69%**
project progress reported to date

## Territorial gradient

- Tellian Atlas and coastal urban corridors: steep slopes, sensitive formations and dense exposure.
- High Plateaus and Saharan margins: different morphologies, climate controls and infrastructure challenges.
- Northern Algeria concentrates recurrent events affecting cities, roads, utilities and agricultural lands.

**1,200+**
km Mediterranean coastline

**18**
major risk categories under Law 24-04

**7+**
recurrent landslide hotspots cited

**Hotspots repeatedly cited: Algiers, Oran, Tizi Ouzou, Béjaïa, Jijel, Constantine and Mila.**

## A continental-scale, multi-risk country

Risk governance is inseparable from territorial planning, public investment and human security.

**2.38 M km²**
largest country in Africa

**69**
wilayas in the territorial organization

**1,200+ km**
Mediterranean coastline

**18**
Hazards/risks recognized by Law 24-04

- **Diverse territories**
  Coastal cities, mountain areas, high plateaus and Saharan spaces require differentiated prevention approaches.

- **Strategic assets**
  Roads, dams, ports, energy systems, hospitals and schools concentrate essential national functions.

# Why landslides emerge as a major geological risk

Instability results from the interaction of natural predisposition, triggering processes and development pressure.

**1 Predisposition**
steep slopes
complex lithology
active geomorphology

**2 Triggers**
intense rainfall
groundwater change
seismic shaking

**3 Pressure**
urban expansion
excavations
networks and drainage

**4 Risk**
exposed settlements
roads and lifelines
territorial disruption

**the landslide hazard becomes a disaster risk when unstable terrain meets people, buildings, networks and critical services.**

Law No. 24-04 — Article 03

# Algeria’s Multi-Hazard Risk Scope

The national legal framework recognizes 18 disaster risk categories — a broad basis for integrated governance, data systems and evidence-based planning.

**18** recognized risk categories

## 03 Geophysical & terrain

- Seismic risks
- Geological risks
- Coastal erosion and sea-level rise

## 06 Hydro-climatic & environmental

- Flood risks
- Extreme climate risks
- Forest fire risks
- Desertification risks
- Drought risks
- Atmospheric, marine and water pollution

## 05 Industrial & technological

- Industrial and energy-related risks
- Space-related risks
- Radiological and nuclear risks
- Cyber risks
- Biotechnological risk

## 03 Health & biological

- Risks affecting human health
- Risks affecting animal and plant health
- Locust risks

## 01 Societal and systemic

- Risks associated with large human gatherings

### Strategic reading

A comprehensive multi-hazard scope allows every risk to be documented, mapped, monitored and reported within a shared national disaster risk information system.

***From legal recognition → standardized data → evidence-based governance → resilient investment***

# Major Earthquakes in Algeria

Historical disasters that shaped national risk governance

## El Asnam Earthquake (1980)

- Magnitude 7.3
- Major urban destruction
- A turning point for seismic awareness

## Boumerdès Earthquake (2003)

- Magnitude 6.8
- Severe human and material losses
- Accelerated legal and institutional reforms

# Major Flood Disaster in Algeria

Bab El Oued floods (2001) and lessons for urban risk governance

## Bab El Oued Floods (2001)


- Flash floods in a dense urban area
- Major human and material losses
- A key lesson for watershed and urban planning

## Why this disaster matters

- Urban flood risk revealed
- Need for drainage and watershed management
- Importance of early warning and local preparedness
- A major reference event in Algeria's disaster memory

**Major disasters in Algeria:**

El Asnam 1980 • **Bab El Oued 2001** • Boumerdès 2003

# Landslide Risk in Algeria- geological risks

National context, Law 24-04 and risk governance for slope instability

## National Landslide Risk Context

- Northern Algeria concentrates exposure: steep slopes, sensitive formations and dense settlements
- Law 24-04 frames major-risk prevention, preparedness, warning and resilience
- DNRM coordination and ASGA susceptibility mapping support risk-informed decisions

## Why this risk matters

- One of Algeria's major geological hazards
- Direct impact on housing, roads and lifelines
- Needs planning controls before construction
- Requires mapping, monitoring and local preparedness

### Major landslide cases in Algeria:

El Biar / Saint-Raphaël • Mila 2020 • Aïn El Hammam • Draa El Mizan • Oran

GEOGRAPHY OF CASES

# Recurring landslide hotspots across northern Algeria

## Events have affected both mountainous territories and dense urban environments.

Image credit: TSA Algérie

### Frequently cited provinces and cities

1. **Algiers / Télemly / El Biar**
   urban slope instability and infrastructure exposure
2. **Oran / Les Planteurs / Si Salah**
   urban slope instability and infrastructure exposure
3. **Tizi Ouzou / Aïn El Hammam / Draa El Mizan**
   mountainous terrain, roads, settlements and cascading effects
4. **Béjaïa and Jijel mountain roads**
   mountainous terrain, roads, settlements and cascading effects
5. **Constantine and Mila**
   mountainous terrain, roads, settlements and cascading effects

Sources: user theme text and source deck; ASGA / CRAAG / Wilaya of Oran communications as compiled in the provided material

# Saint-Raphaël / El Biar Landslide

A long-term urban instability case in Algiers and a 2024 risk-reduction working group

## El Biar – Saint-Raphaël Landslide


- Historical reactivations and extensions observed from 1785 to recent years
- Hydrology, molasse cliffs, schists and rupture surfaces control the movement
- A working group installed in 2024 supports coordinated risk reduction in El Biar

*Based on the Télemly / Saint-Raphaël landslide case study and user instruction*

## Why this case matters

- **Shows how old movements can reactivate**
- **Dense urban fabric increases vulnerability**
- **Post-seismic effects can worsen instability**
- **Needs real-time monitoring and geotechnical diagnosis**

**Reference sequence:**

1785 movements • 2003 fissuring • 2011 Saint-Raphaël collapse • 2024 working group

Sources: ASGA, CRAAG and Wilaya of Oran communications; user theme text

# Mila, Aïn El Hammam and Draa El Mizan

Case studies showing cascading hazards, mountain vulnerability and susceptibility mapping

## Three Case Studies in Northern Algeria

- **Mila: major slope instability was reported following the 2020 earthquake sequence**
- **Aïn El Hammam: mountain urbanization and steep terrain increase exposure**
- **Draa El Mizan: susceptibility mapping helps identify zones requiring control**

*Based on the ASGA susceptibility mapping material and user-selected case studies*

## Why these cases matter

- **Earthquakes can trigger or reactivate ground movements**
- **Water, drainage and slope geometry drive instability**
- **Maps support safer territorial planning**
- **Local diagnosis must feed national prevention**

**Case-study logic:**

Mila 2020: cascading hazard • Aïn El Hammam: mountain exposure • Draa El Mizan: planning support

Sources: ASGA, CRAAG and Wilaya of Oran communications; user theme text

# Oran Landslide and Lessons Learned

From emergency response to safer recovery and urban risk governance

## Oran – Les Planteurs / Si Salah Experience

- Unstable ravined terrain combined with dense and vulnerable constructions
- Emergency response required security, rescue, diagnosis and relocation
- Lessons: prevent reoccupation, control urbanization and prioritize monitoring

*Based on the Oran landslide crisis material and consolidated lessons learned*

## Lessons for Algeria

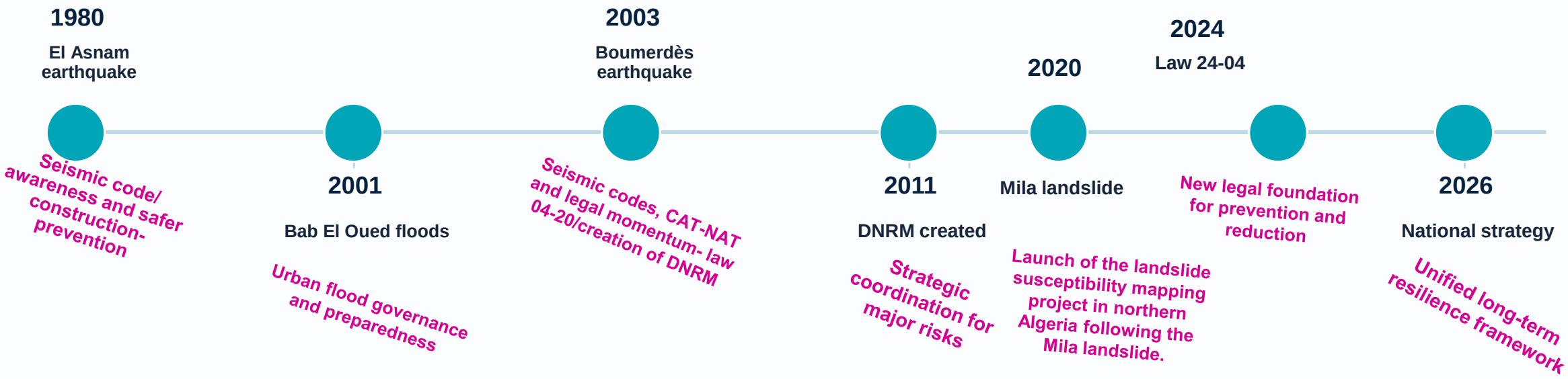
- Move from reaction to prevention
- Reduce exposure before damage occurs
- Connect ORSEC, DNRM, ASGA and local services
- Recover safely and prevent return to danger zones

**Integrated chain:**

Map • Plan • Monitor • Prepare • Respond • Relocate • Prevent reoccupation

# Historical memory produced reform

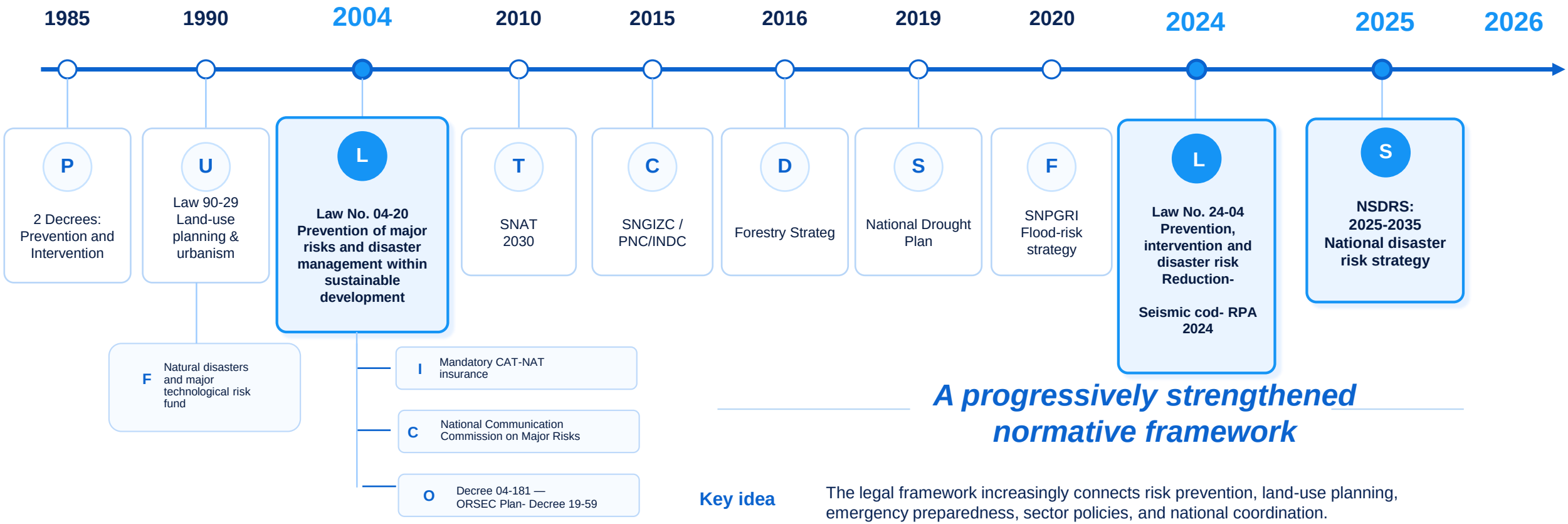
Major events transformed Algeria’s understanding of risk and the structure of public action.




**The current governance system is the result of accumulated lessons: each disaster revealed vulnerabilities, then generated legal, institutional, operational and financial improvements.**

# National context: regulatory framework governing DRM

*A progressively strengthened normative framework for prevention, preparedness and disaster risk reduction*




***A progressively strengthened normative framework***

**Key idea**

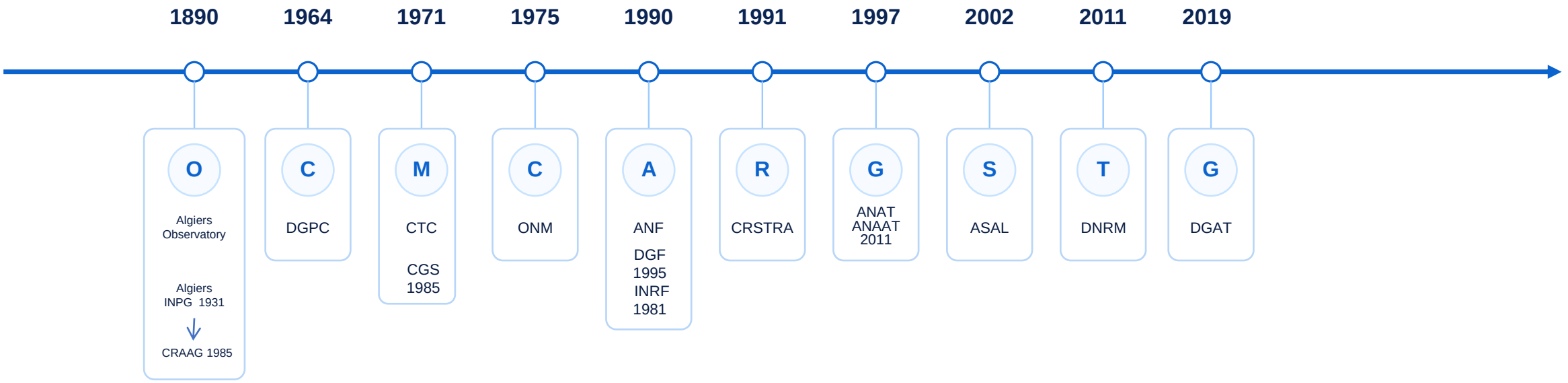
The legal framework increasingly connects risk prevention, land-use planning, emergency preparedness, sector policies, and national coordination.

✓ **Key levers**

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **P** | Risk prevention | **R** | Disaster management | **V** | Vulnerability reduction | **G** | Planning & governance | **C** | Intersectoral coordination |

# National context: institutional framework governing DRM

*A long institutional trajectory combining scientific monitoring, operational response and strategic coordination*

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**Prevention and response institutions have been progressively strengthened.**

In parallel, Law No. 91-23 defines the modalities for the participation of the National People's Army in safeguarding public order during exceptional situations.

**2003 Boumerdès earthquake**

A major turning point that accelerated legal and institutional reinforcement.-creation of DNRM

**2011 — DNRM/Ministry of the Interior**

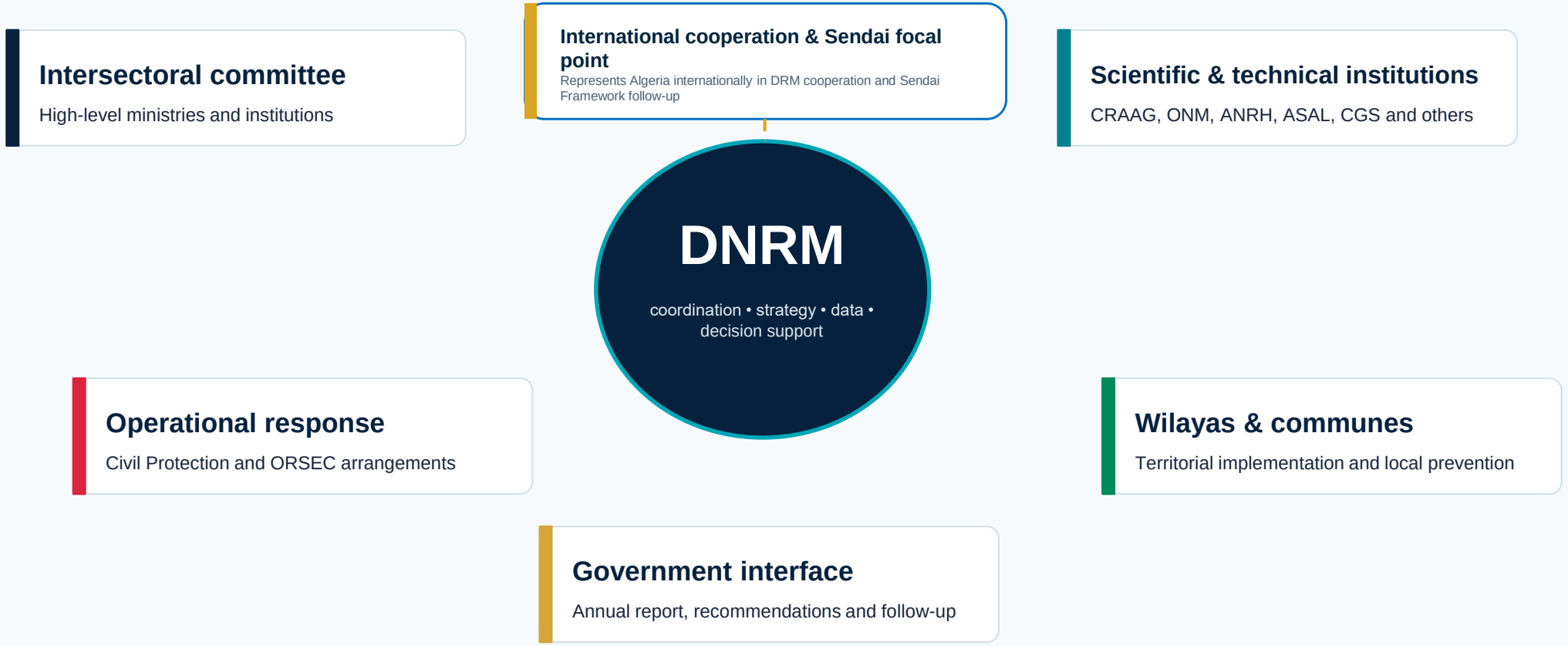
Strategic oversight and territorial coordination

✓ **Other key actors**

- C DGPC
- W ANRH
- M Sectoral ministries
- L Wilayas and communes

# DNRM as a national coordination node

A dedicated institution helps turn dispersed information into strategic guidance and coordinated action.

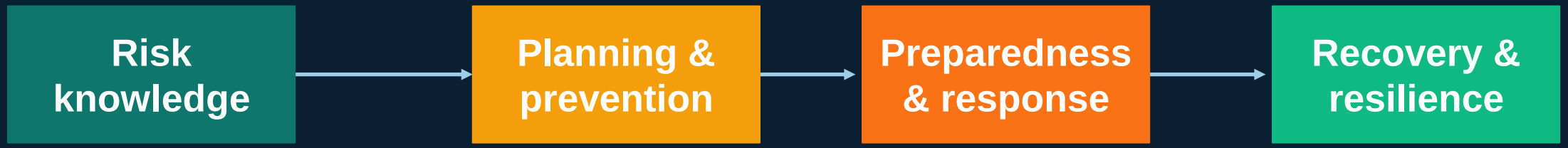



**Strength: institutional spaces exist to compare evidence, harmonize methods, validate priorities and support national accountability.**

GOVERNANCE

# The risk system needs science, authority and operations

Algeria has progressively strengthened the framework for geological risk prevention through ASGA technical work, local crisis coordination and the national disaster-risk governance framework.




ASGA: analysis and prevention of geological hazards outside seismic activities; ground movements, floods and coastal hazards.

Wilaya / Wali: ORSEC activation, mobilization of technical services and coordination of emergency actors.

Law No. 24-04: prevention, preparedness, monitoring, early warning and resilience among national priorities.

Institutional and operational elements consolidated from ASGA and Wilaya of Oran communications; Law No. 24-04 from user theme

# Landslide Risk in Algeria

Algeria is exposed to various geological hazards, with landslides representing one of the most significant threats, particularly in the northern regions characterized by rugged terrain, sensitive geological formations, and rapid urbanization.

Several provinces, including **Algiers, Constantine, Tizi Ouzou, Mila, Jijel, Béjaïa, and Oran**, have experienced repeated slope instability events, resulting in:

- Damage to or destruction of buildings
- Disruption of transport networks
- Relocation of thousands of residents
- High costs related to stabilization works, infrastructure repair, housing reconstruction, and emergency management

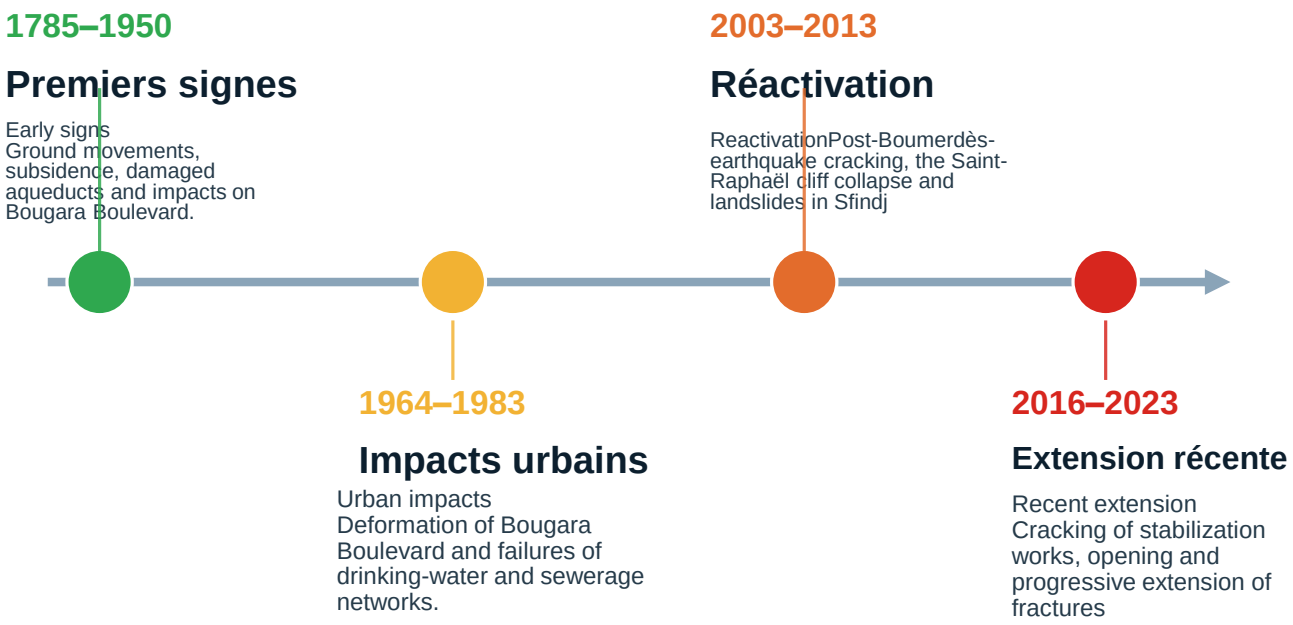
In response, ASGA has prioritized the inventory and mapping of landslide susceptibility across northern Algeria to identify the areas most exposed to this hazard.

Sources: ASGA, CRAAG and Wilaya of Oran communications; user theme text

# Glissement de terrain d’El Biar

Documented historical milestones and recent warning signs

The site has a long history of recurrent instability, with repeated impacts on roads, utility networks and retaining structures..




## Key events

**1785–1950:** Subsidence, ground movements and damage to hydraulic structures.
**1964–1983:** Road-surface deformation and pipeline failures.
**2003–2013:** Post-earthquake cracking, cliff collapse and landslides.
**2016–2023:** Open fractures, deformation of stabilization works and observed extension of the unstable area.
*Referenced studies: Derveux (1948) · Sols Expert International (1978) · Bouzid (1984) · Bougdal (2007) · Cheikhounis (2011) · Hallal et al. (2019)*

*Travaux référencés : Derveux (1948) · Sols Expert International (1978) · Bouzid (1984) · Bougdal (2007) · Cheikhounis (2011) · Hallal et al. (2019)*

# Oran Landslide

## Les Planteurs / Es-Sanaoubar · Local crisis management example

Event recorded in late April 2025 in a dense, steep and vulnerable urban sector.
The affected area is located on the eastern flank of the Murdjadjo, in the Si-Salah / former Les Planteurs district.
The case illustrates how a landslide becomes an urban crisis: human losses, unsafe housing, technical uncertainty, relocation and demolition.

CASE STUDY — LES PLANTEURS / ARD CHEBAT

# Oran landslide: site context and predisposing factors

A post-catastrophe reading of the Si-Salah / Haï Sanaoubar slope failure, triggered after intense rainfall episodes.

**Intervention zone estimated at around 4.6 ha**

Dense informal urban fabric on steep terrain

Visible scar and exposed landslide front

**4.6 ha**

affected intervention area

**>25%**

slope in critical sectors

**3**

interconnected tunnels identified

- Heterogeneous ground: unstable fills over sandstone–limestone–clayey formations.
- Historic instability, rockfall and soil detachment in a sector previously considered non-buildable.

Source: Rapport post-catastrophe — Glissement de terrain, Ard Chebat / Les Planteurs, Wilaya d'Oran, 26–27 April 2025

# Emergency governance and operational response

From immediate rescue to inter-sectoral coordination

## Security and rescue measures

Immediate police deployment to secure and cordon the site.
Continuous 24/7 security during rescue, relocation and demolition phases.
Civil Protection units mobilized: rubble-rescue teams, canine teams and units for difficult steep zones.
Operational command post established near the site to manage rescue, evacuation and extraction.

## Institutional coordination

The wali coordinated the response through requisitions and activation of the ORSEC framework.
Local actors involved: municipality, daïra commissions, housing/urban planning, public works, network managers and security services.
Central authorities were mobilized to support urgent social care, technical diagnosis and rehousing decisions.

**A**

### Rescue and securing

Life-saving actions, perimeter control and protection of responders and residents.

**B**

### Technical diagnosis

Installation of CTC expertise teams and damage assessment by construction type.

**C**

### Social care

Census of affected families and immediate organization of relocation solutions.

Source: Wilaya of Oran communication on local crisis management for landslides, case of Oran

# Emergency governance: rescue, security and relocation

The crisis response combined life-saving operations, multisectoral coordination, technical assessment and immediate social care.

First rescue operations during the night

Crisis coordination and institutional follow-up

Relocation sites for affected households

**00:05**

**Civil Protection intervention**

4 specialized trucks, 5 ambulances and a canine search unit mobilized.

**01:00**

**Security perimeter**

Site cordoned; more than 150 residents evacuated to a secure assembly point.

**24h**

**Central support**

Three ministers visited the affected area and supported urgent decisions.

**2,135**

**People relocated**

Estimated population moved through successive rehousing phases.

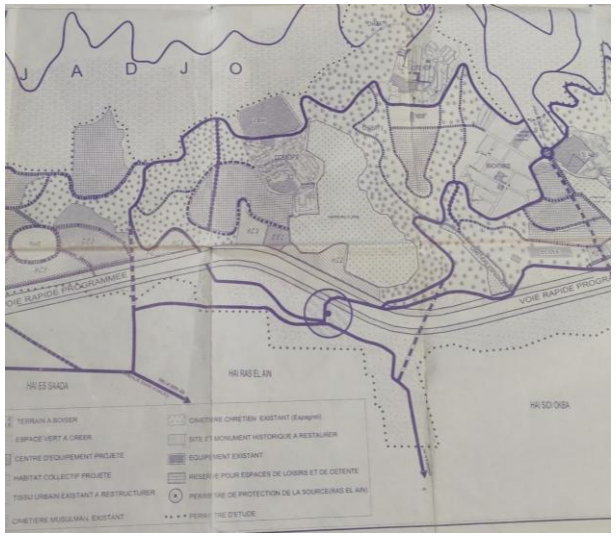
Source: Rapport post-catastrophe — Glissement de terrain, Ard Chebat / Les Planteurs, Wilaya d’Oran, 26–27 April 2025

RECOMMENDATIONS

# Lessons learned: convert recovery into long-term risk reduction

The Oran case shows the need to move beyond emergency response toward prevention, controlled land use and permanent monitoring.


Demolition and exposure reduction after evacuation




Technical mapping of the affected sector

Field visits and public decision-making

## Control exposure

Strictly enforce POS / PDAU non-aedificandi status and prevent reoccupation of dangerous areas.

## Map and monitor

Update risk maps for informal districts; combine geotechnical sensors, drones and field inspections.

## Alert and coordinate

Automatic activation of the wilaya watch cell; sirens, SMS alerts and clear ORSEC procedures.

## Recover safely

Secure debris removal, technical tunnel expertise, psychosocial support and environmental restoration.

Source: Rapport post-catastrophe — Glissement de terrain, Ard Chebat / Les Planteurs, Wilaya d'Oran, 26–27 April 2025

CASE STUDY 3 - Aïn El Hammam

# Landslide
# Aïn El Hammam

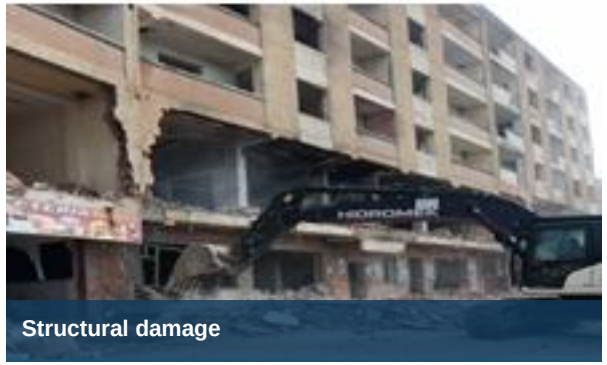
Example of urban landslide management: assessment, safety, rehousing, demolition, studies and stabilization

**Tizi Ouzou**

# Context and challenges

An active landslide in a dense urban fabric, directly affecting buildings, roads and activities.

Exposed buildings



Structural damage

Urbanized slope

Deconstruction

## Management issue

The town combines the hazard, human stakes, economic functions and networks. The response cannot be purely technical: it must combine diagnosis, protection of people, administrative decisions, rehousing and long-term slope treatment.

**Hazard** **Exposure** **Vulnerability**

**Objective: reduce risk without shifting the problem to other unstable areas.**



Sources: Djerbal & Melbouci, 2012; Boudjemia et al., 2019; APS/Algérie Eco, 2022

# 2. Technical reading of the phenomenon

Understand the mechanism before deciding on works or land-use restrictions.

## Passive factors

**1** Geology and morphology
weathered schist formations, steep slopes, superimposed failure surfaces

**2** Slope hydrology
infiltration, pore pressure, groundwater fluctuations

## Active factors

**3** Rainfall and reactivation
acceleration phases observed after rainy episodes

**4** Human actions
overloads, earthworks, networks and site urbanization

**Key point**

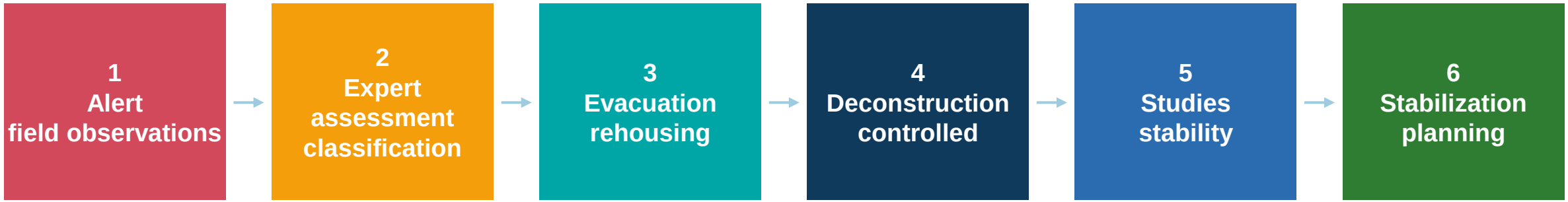
The landslide shows evolving behavior: shallow, deep and potentially very deep. Management must therefore be phased and revisable, with monitoring and intervention scenarios.



Sources: Djerbal & Melbouci, 2012; Boudjemia et al., 2019

# 3. Management process followed

An operational sequence combining immediate safety and long-term treatment.




## Management logic

The first priority is protecting people. Restoration comes only after understanding the mechanism, clearing high-risk areas and defining suitable works.

**Progressive decision-making**

**Immediate measures → studies → works → monitoring**



Sources: APS/Algérie Eco, 2022; national press, 2023

# 5. Study phase: from observation to solution

Studies guide the choice between drainage, retaining works, regrading, restrictions and monitoring.

## Analysis chain

| Topography & mapping | Geotechnical investigations | Instrumented monitoring | Modeling & scenarios |
|---|---|---|---|
| landslide limits, active zones, structures and networks | boreholes, tests, mechanical properties, water levels | piezometers, inclinometers, displacement markers | shallow / deep failure, role of water, effects of overloads |

**Evidence-based technical decision**

The expected outcome is not only a report: it is a phased, budgeted action program prioritized by urgency and safety gain.



Sources: Djerbal & Melbouci, 2012; Boudjemia et al., 2019

# 6. Treatment phase: stabilize and redevelop

Stabilization must address aggravating causes, not only visible effects.

Slope and buildings

## Treatment axes

1. Water control
   surface drainage, water capture, network rehabilitation
2. Load reduction
   deconstruction, fill control, prohibition of overloads
3. Targeted retaining works
   works adapted to failure surfaces and movement depth
4. Controlled planning
   land regulation, non-buildable spaces, resilient roads and networks

## Success conditions

✓ works phased according to danger level
✓ funding secured after studies
✓ coordination: urban planning – public works – hydraulics – civil protection
✓ monitoring maintained after works

**The objective is sustainable risk reduction, not a return to previous urbanization without conditions.**



Source: management approach adapted to factors identified in scientific studies

# Mila Landslide

## Example of management of an earthquake-induced landslide

7 August 2020 earthquake · Magnitude 4.9 · El Kherba area

Rapid field recognition, technical diagnosis, risk zoning, emergency support, relocation and post-event monitoring.



# 1. Triggering event and observed effects

From the seismic signal to visible damage on the ground and buildings


## Recorded induced effects

Landslide movement and surface cracking.
Damage to gas and sewerage networks.
Total collapse of some buildings.
Structural and non-structural damage of varying severity.

## Management reading

The event had to be treated as a multi-impact crisis: geotechnical hazard, vulnerable buildings and disruption of essential services were all present at the same time.

Source: Communication “Mila Earthquake Meeting” – 14.12.2022

# 2. Technical diagnosis and identification of causes

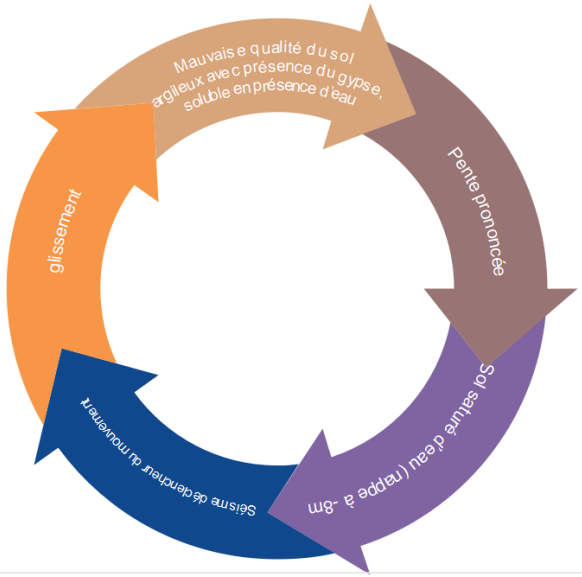
Decision-making based on field observation, measurements and modelling


## Main factors identified

1. Earthquake considered the triggering factor.
2. Low-quality clayey soil with gypsum, sensitive to water.
3. High saturation linked to the groundwater table.
4. Steep site morphology, with an estimated 15% slope.

## Investigations used

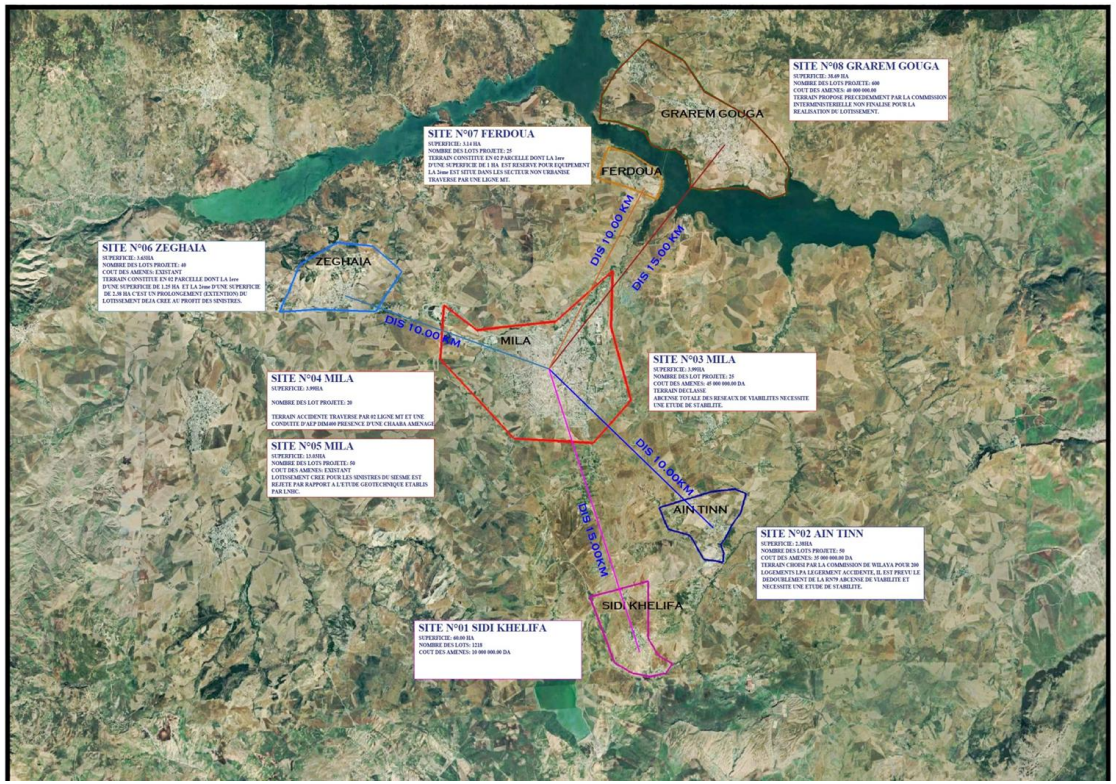
Inclinometer measurements · numerical simulation · drone monitoring · correlation between field measurements and the evolution of damage.




Source: Communication “Mila Earthquake Meeting” – 14.12.2022

# 3. Risk zoning and exposure of populations

Hazard mapping guided evacuation, relocation and protection decisions




**128.37 ha**
red zone
very high risk

**10.85 ha**
orange zone
moderate risk

**1,720**
households exposed
in the red zone

**315**
households exposed
in the orange zone

## Operational implications

The red zone was treated as the priority evacuation and relocation area.
The orange zone required monitoring because vulnerability can evolve over time.
A buffer zone helped clarify residual risk around the unstable sector.

The zoning translated scientific diagnosis into practical decisions for people, housing, land-use control and infrastructure works.

Source: Communication “Mila Earthquake Meeting” – 14.12.2022

CASE STUDY 5 — TIZI OUZOU

# Draâ El Mizan landslide: Ouled Aïssa, 25 February 2025

A major slope movement affecting homes, local access, utility networks and the Tizi Ouzou–East–West motorway link corridor.

Ground cracking and slope deformation near dwellings — public Facebook/local photo post, 27 Feb. 2025.

**19–20 ha**
estimated unstable area

**92**
private dwellings affected

**55**
homes classified R5 / red

**24h**
rapid rehousing window

- The slide generated ground fissures, swelling and structural disorders that made several buildings uninhabitable.
- The affected sector lies on a sloping terrain in Ouled Aïssa, commune of Draâ El Mizan.

Sources: Daïra de Draâ El Mizan post-disaster report; LCTP final technical report; public Facebook / local online photo posts, Feb.–Mar. 2025.

RESPONSE AND RISK REDUCTION

# Management lessons: from emergency relocation to prevention

The case highlights the need for risk mapping, permanent monitoring, water control and strict planning discipline in vulnerable areas.

Affected access and field operations after the 25 February 2025 event.

**Key message: treat the site as a moving system — not only as damaged buildings.**

### Alert

Event declared and authorities moved to the site.

### Shelter

Temporary reception at Ali Mellah high-school dormitory and local facilities.

### Rehouse

Families moved to new LPL housing within 24 hours.

### Study

Geotechnical expertise, monitoring and stabilization options.

## Technical reading

- The landslide is deep: inclinometer shear depths ranged from about 8 to 43 m.
- Piezometers confirmed groundwater between 2.6 and 13.4 m below the ground surface.

## Priority actions

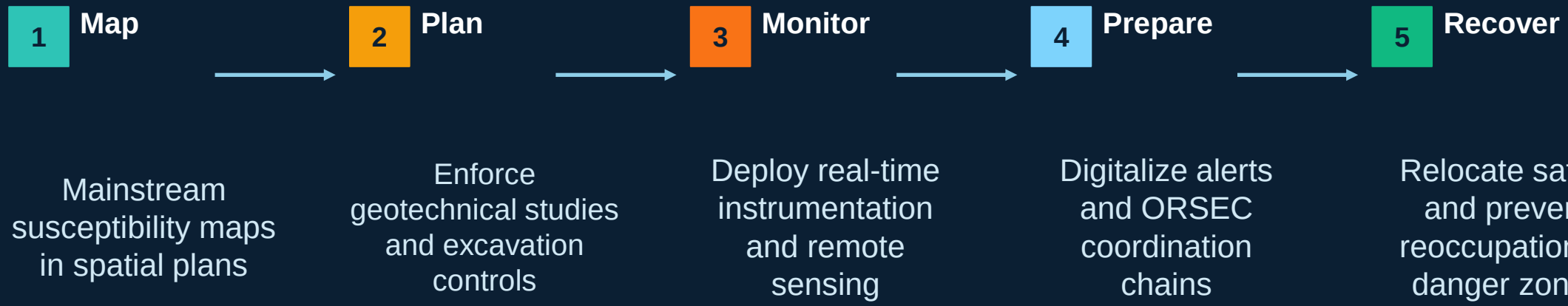
- Build a regional database of landslides and vulnerable zones.
- Share risk information with technical services before locating new projects.
- Prepare emergency plans and maintain monitoring for active slopes.

Sources: Daïra de Draâ El Mizan post-disaster report; LCTP final technical report; public Facebook / local online photo posts, Feb.–Mar. 2025.

INTEGRATED ROADMAP

# Five priorities for proactive landslide risk reduction

The Algerian experience points toward a shift from reacting to damage toward anticipatory governance aligned with risk knowledge, monitoring and resilience.




Roadmap synthesized from the three communications and user theme

# From response to resilience

- Algeria is strengthening landslide risk reduction through the preparation of General Plans for the Prevention of Geological Risks, as established under Law No. 24-04.
- These plans should support hazard identification, risk mapping, land-use regulation, monitoring, early warning and coordinated preparedness.
- This process is aligned with the National Strategy for Disaster Risk Management and Reduction 2025–2026, which promotes a shift from emergency-driven action towards prevention, risk-informed planning and territorial resilience.
- Landslide management remains particularly complex because it involves interacting geological, hydrological, climatic and human factors. Moreover, several geological hazards in Algeria are still insufficiently identified, characterized or mapped, and national assessment work remains ongoing.

**Key message**

**Building resilience requires comprehensive geological-risk knowledge, enforceable prevention plans and sustained coordination between scientific institutions, public authorities and local communities.**

Thank you