
# Themes # 1

# Seismic hazard analysis and mapping

# ASSESSMENT OF SEISMIC HAZARD IN NORTHERN ALGERIA

# EXPERIENCE OF PLAN ORSEC

# National Emergency Action Plan (ORSEC Plan)

**Energoprojekt-Hidroinzenjering l.t.d.**
**Serbia**

**Energoprojekt - Hidroinženjering J.S.C has been successful in engineering seismology and earthquake engineering in the country and abroad, for several decades.**


**This implies:**

1. **Seismic hazard analysis**
   a) Regional seismic studies
   b) Seismic studies for dams and ancillary facilities

2. **Seismic micro-reionization**

3. **Analysis for potential Reservoir Triggered Earthquakes (RTE)**

4. **Analysis of seismogenic capacities of specific faults**

5. **Seismic auscultations on the dams**

The region of Northern Algeria has been struck by the following three disastrous earthquakes in :

- 09.09.1954 (Ms=6.8, h=5km), Orleansville, in Chelif area,
- 10.10.1980. (Ms=7.3, h=10 km) El Asnam, in Chelif area and
- 21.05.2003 (Mw=6.8, h=10km) in the vicinity of Boumerdes.

It has been assessed that only in the period between 1716 and 1989, the earthquakes caused death of more than 34,440 people.

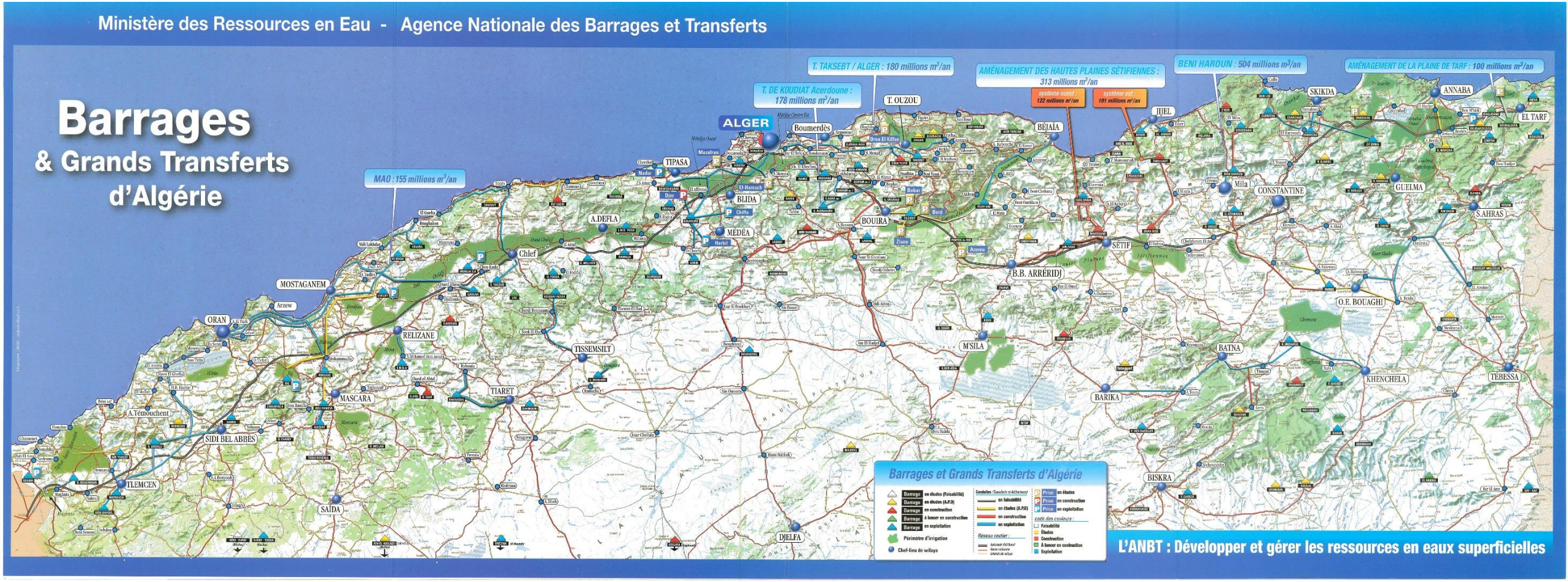
The earthquake in Boumerdes

- magnitude was Mw=6.8,
- focal depth h=10 km,
- whereas duration of shaking was T=18 s.

# CHARACTERISTICS OF THE ALGERIAN EARTHQUAKES

1. Earthquakes are generally shallow, approximately 10 km
2. They are often caused by faults which were not known previously
   a) underwater faults
   b) blind faults
3. Minor dimensions of the fault may generate magnitudes stronger than expected (examples: El Asnam and Boumerdes)
4. Seismic accelerations may be greater than those expected (example: Boumerdes)

# ORSEC PLAN (NATIONAL EMERGENCY RESPONSE PLAN) FOR 28 DAMS LOCATED IN THE REGIONS CENTER AND EAST IN THE NORTHERN ALGERIA



# INVESTIGATED DAMS

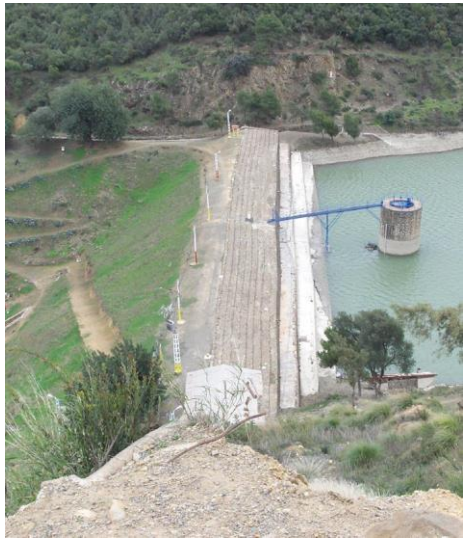
## Region Center

## Region Est

# Table 1.

| Dam | Year of the construction | PGA (g) projected | PGA (g ) RPA-99 | PGA(g) RPA-99(2003) | Seismometers |
|---|---|---|---|---|---|
| 01.Keddara | 1985 | 0.25 | 0.25 | 0.30 | yes |
| 02.Hamiz | 1879(1935) | 0.30 | 0.25 | 0.30 | no |
| 03.Meurad | 1867 | x | 0.25 | 0.40 | no |
| 04.Lekhal | 1985 | x | 0.25 | 0.25 | no |
| 05.Bouroumi | 1986 | 0.18 | 0.25 | 0.30 | no |
| 06.Harbil | 1989 | x | 0.25 | 0.30 | no |
| 07.Ladrat | 1989 | 0.20 | 0.25 | 0.25 | no |
| 08.Boukourdane | 1992 | 0.25 | 0.25 | 0.40 | yes |
| 09. Amrane | 1988 | 0.24 | 0.25 | 0.30 | yes |
| 10. K'Sob | 1940 | x | 0.25 | 0.25 | no |
| 11.Ain Zada | 1986 | 0.13 | 0.25 | 0.25 | no |
| 12.Taksebt | 2002 | 0.12 | 0.25 | 0.25 | yes |
| 13. Cheffia | 1965 | 0.39 | 0.25 | 0.25 | yes |
| 14. Zardezas | 1974 | 0.40 | 0.25 | 0.25 | no |
| 15. Guenitra | 1984 | x | 0.25 | 0.25 | no |
| 16.HammamGrouz | 1987 | 0.27 | 0.25 | 0.25 | yes |
| 17.HammamDebagh | 1987 | 0.17 | 0.25 | 0.25 | yes |
| 18. Ain Dalia | 1987 | 0.30 | 0.12 | 0.15 | no |
| 19. Zid | 1997 | 0.27 | 0.25 | 0.25 | no |
| 20. Babar | 1995 | 0.36 | 0.12 | 0.15 | no |
| 21. Oued Cherf | 1995 | 0.20 | 0.12 | 0.15 | no |
| 22. Mexa | 2002 | 0.35 | 0.25 | 0.25 | no |
| 23.F. Gazelles | 2000 | x | 0.12 | 0.15 | no |
| 24. Zit El Emba | 2001 | x | 0.25 | 0.25 | no |
| 25. El Agrem | 2002 | 0.25 | 0.25 | 0.25 | no |
| 26. Haroun | 2002 | 0.30 | 0.25 | 0.25 | yes |
| 27.Foum ElGueiss | 1939 | 0.33 | 0.12 | 0.15 | no |
| 28.Foum ElGherza | 1957 | x | 0.12 | 0.15 | no |


Boukourdane



Meurad

Keddara

Beni Amrane

Hamiz

# APPLIED METHODOLOGY

By introducing the given risk level and structure lifetime in the calculations, relations for a return period are obtained independently from the analyzed value. As according to Poisson's distribution:

$$R=(1-e^{-te/Tr}) \Rightarrow Tr = \frac{t_e}{\ln(1/R)}$$

Where:

R – given seismic risk level

$t_e$ – structure lifetime in years

$T_r$ – return period of the analyzed phenomenon

The above relation gives the return period Tr = 144.26 years for the lifetime of 100 years and risk level of R = 50%, Tr= 218 years for the risk level of R ≅ 37% (1/e), Tr = 949.12 years for the maximal design earthquake with the risk level of R = 10% and Tr = 9950 years for the maximal design earthquake with the risk level of R = 1%.

Seismic hazard maps of Northeast Algeria were prepared for these return periods, by using the average value from the four applied attenuation relations.

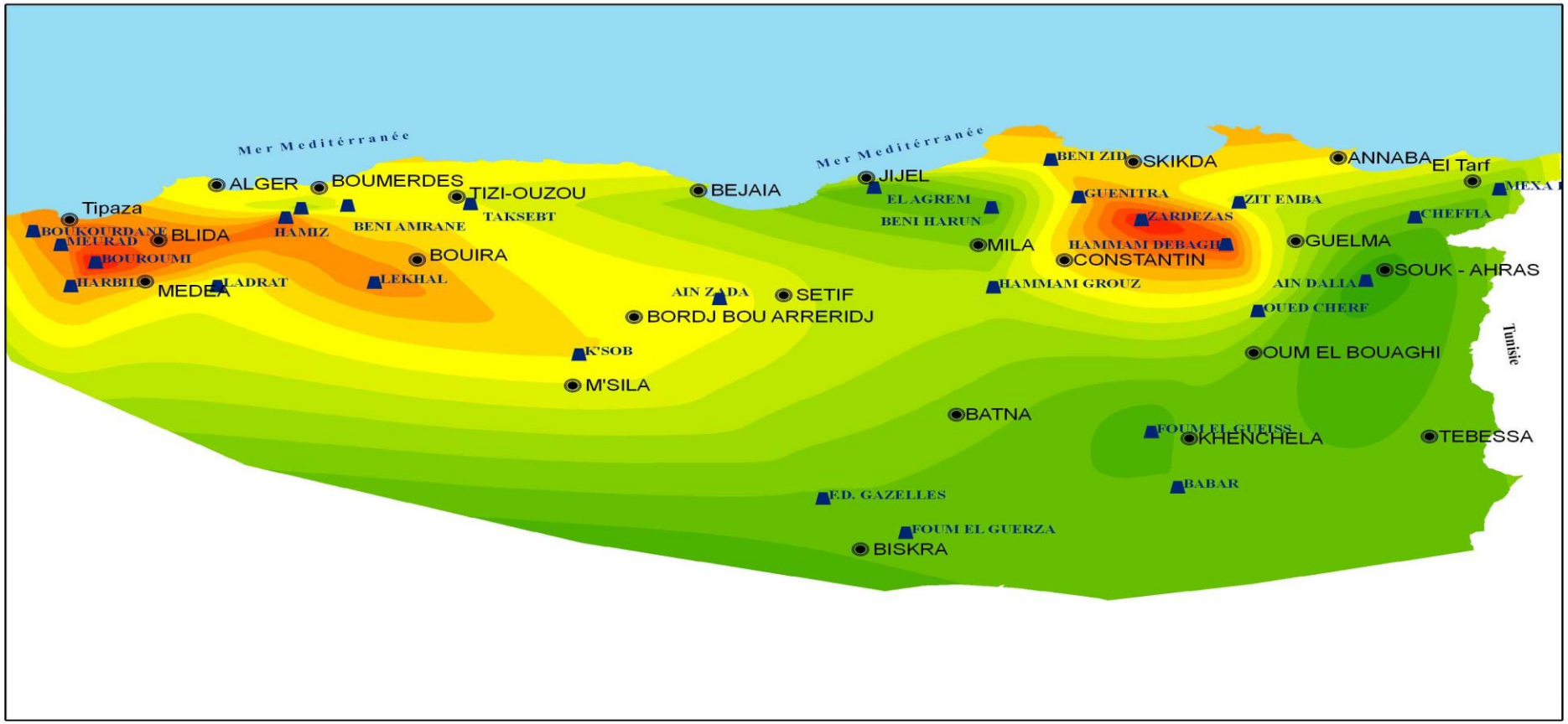
# RESULTS

| Number | Dam | Maximum peak acceleration (cm/s²) |
|---|---|---|
| 1 | Zardezas | 467,23 |
| 2 | Hammam Debagh | 459,41 |
| 3 | Guenitra | 351,60 |
| 4 | Zit Emba | 309,10 |
| 5 | Hammam Grouz | 287,39 |
| 6 | Oued Cherf | 271,30 |
| 7 | Foum El Gherza | 258,62 |
| 8 | Zid | 250,86 |
| 9 | F. Des Gazelles | 245,61 |
| 10 | Mexa | 209,28 |
| 11 | Beni-Haroun | 208,66 |
| 12 | Foum El Gueiss | 208,44 |
| 13 | El Agrem | 204,17 |
| 14 | Cheffia | 189,82 |
| 15 | Babar | 162,54 |
| 16 | Ain Dalia | 127,30 |

| Number | Dam | Maximum peak acceleration (cm/s²) |
|---|---|---|
| 1 | Bouroumi | 445,45 |
| 2 | Hamiz | 400,95 |
| 3 | Meurad | 383,77 |
| 4 | Lekhal | 382,17 |
| 5 | Boukourdane | 377,66 |
| 6 | Harbil | 366,49 |
| 7 | K'Sob | 347,87 |
| 8 | Taksbet | 338,05 |
| 9 | Beni-Amrane | 332,38 |
| 10 | Ain-Zada | 325,48 |
| 11 | Keddara | 280,38 |
| 12 | Ladrat | 267,19 |

The tables present the values of the maximum peak accelerations obtained for the return period of Tr = 10,000 years, increased by 1σ

**Carte des accélérations horizontales de pointe pour la période de retour de 144.26 ans. Region Centre**



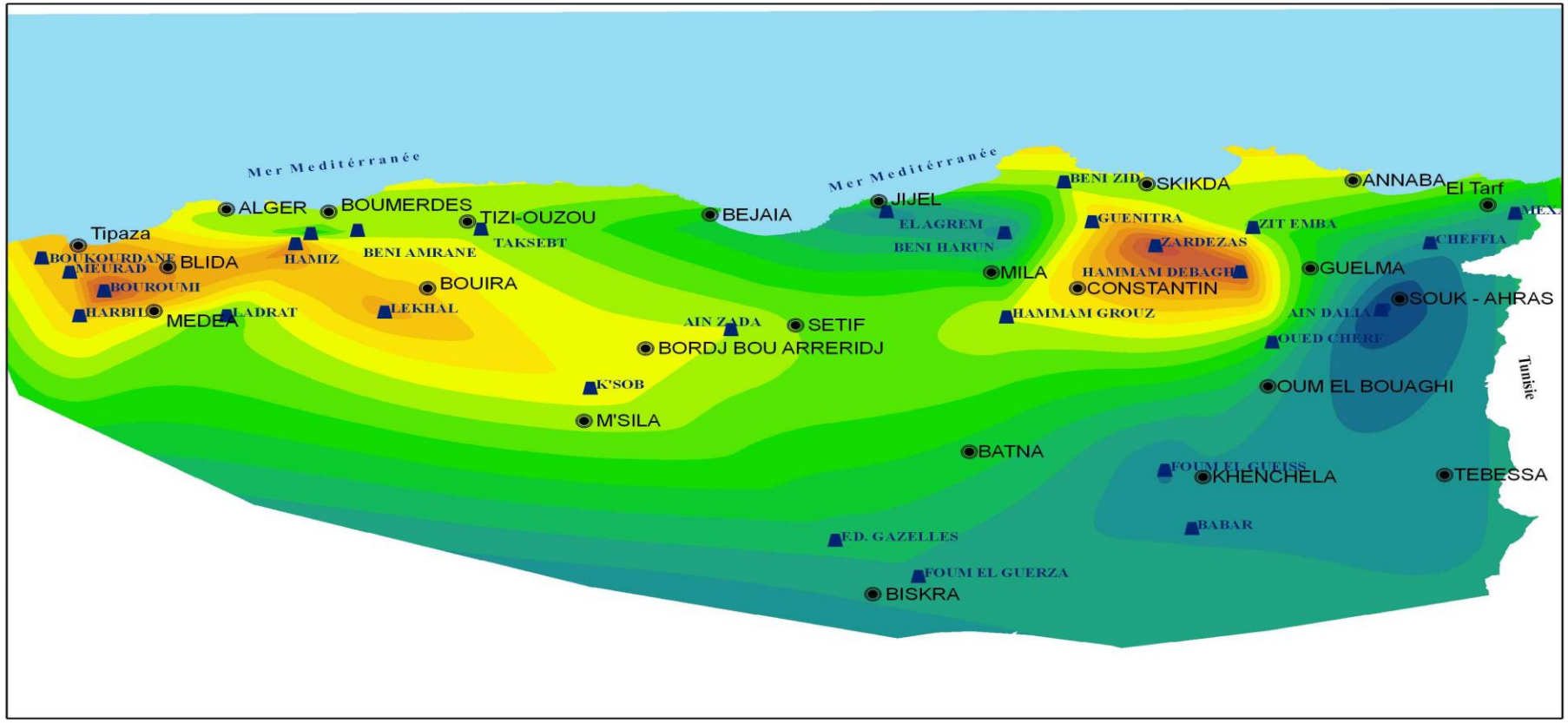

zone de accélération horizontale de pointe ( cm/s2))

60 - 70 | 71 - 80 | 81 - 90 | 91 - 100 | 101 - 110 | 111 - 120 | 121 - 130 | 131 - 140 | 141 - 150 | 151 - 160 | 161 - 170 | 171 - 180 | 181 - 190 | 191 - 200 | 201 - 210

ALGER Villes principales

LADRAT Site de barrage

**Carte des accélérations horizontales de pointe pour la période de retour de 218.00 ans. Region Centre**



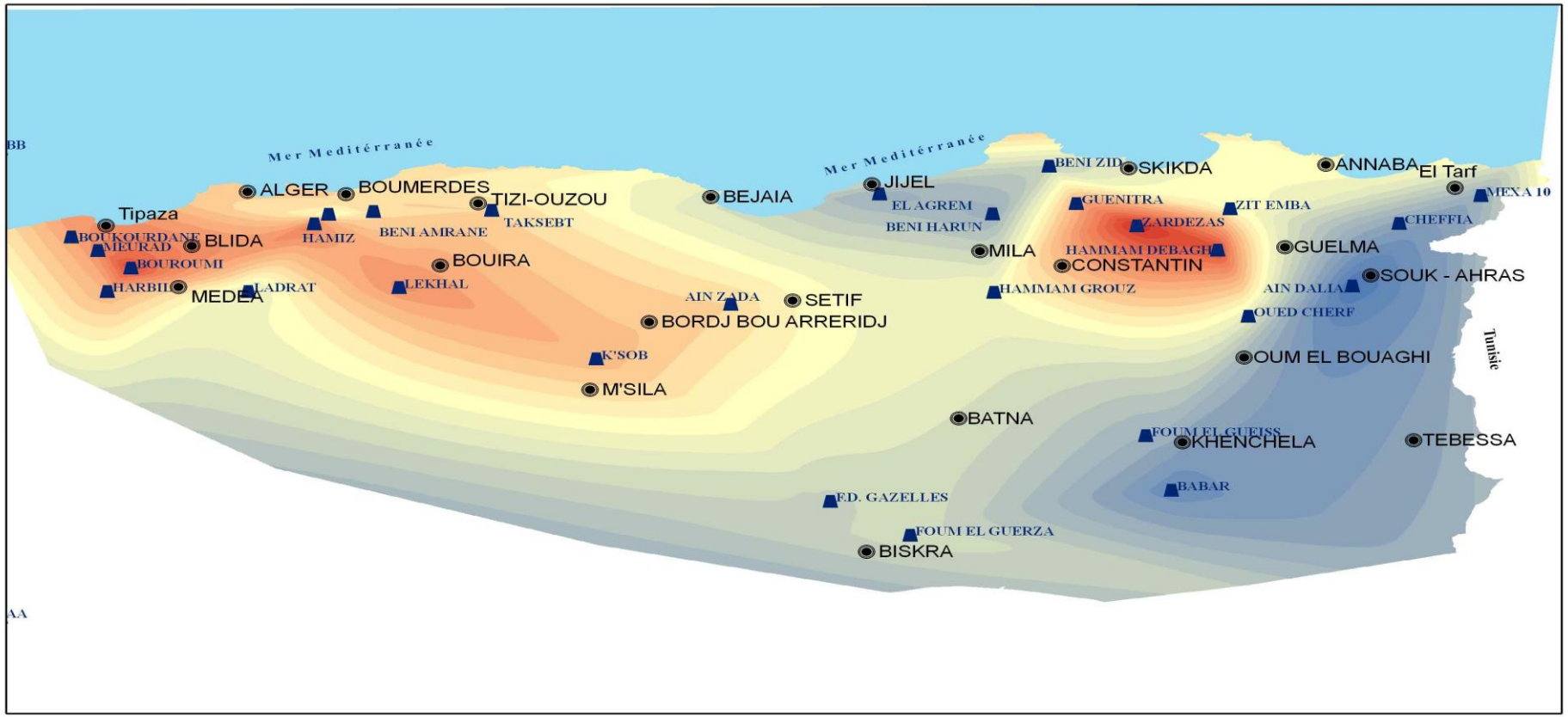

*zone de accélération horizontale de pointe ( cm/s2))*

67 - 70 | 71 - 80 | 81 - 90 | 91 - 100 | 101 - 110 | 111 - 120 | 121 - 130 | 131 - 140 | 141 - 150 | 151 - 160 | 161 - 170 | 171 - 180 | 181 - 190 | 191 - 200 | 201 - 210 | 211 - 220 | 221 - 230 | 231 - 240

ALGER — Villes principales

LADRAT — Site de barrage

**Carte des accélérations horizontales de pointe pour la période de retour de 950 ans. Region Centre**



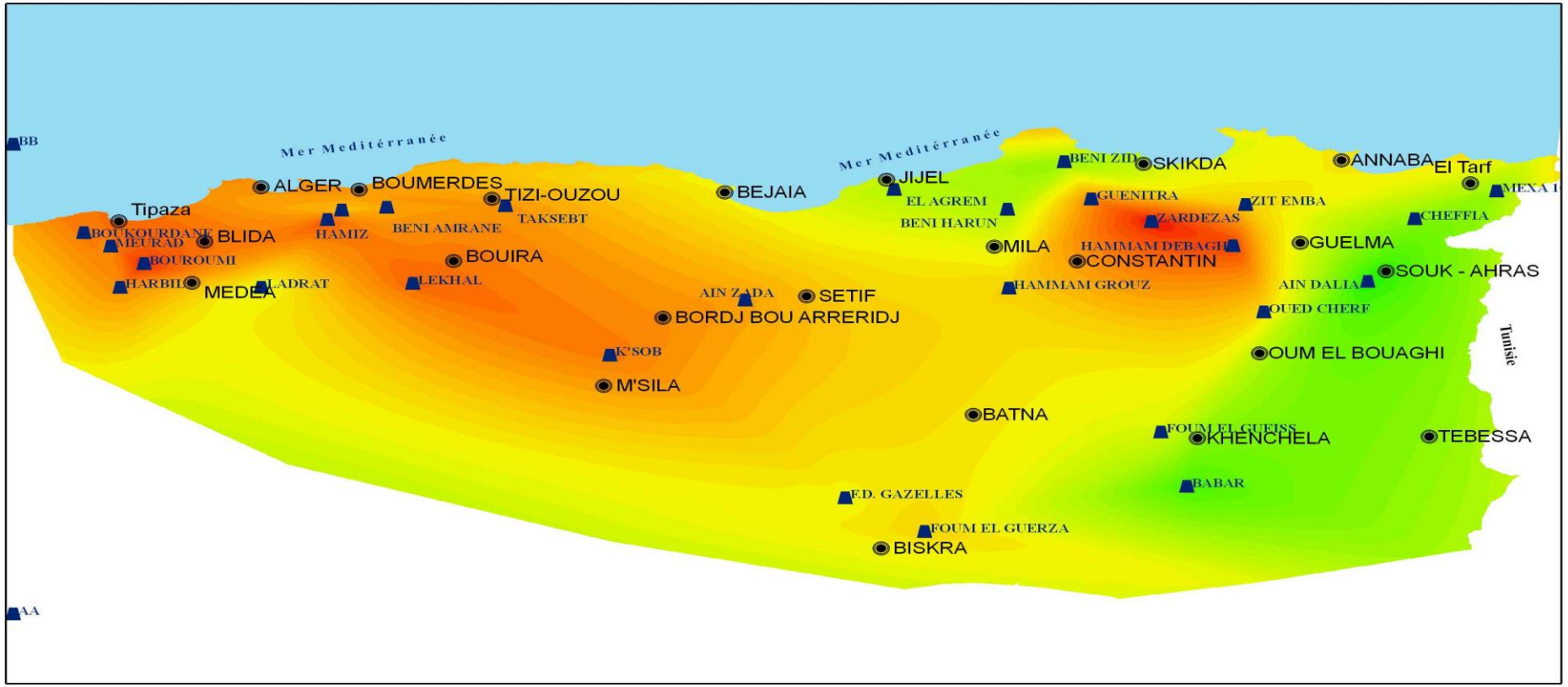

*zone de accélération horizontale de pointe ( cm/s2))*

98 - 100 | 101 - 110 | 111 - 120 | 121 - 130 | 131 - 140 | 141 - 150 | 151 - 160 | 161 - 170 | 171 - 180 | 181 - 190 | 191 - 200 | 201 - 210 | 211 - 220 | 221 - 230 | 231 - 240 | 241 - 250 | 251 - 260 | 261 - 270 | 271 - 280 | 281 - 290 | 291 - 300 | 301 - 310 | 311 - 320 | 321 - 330 | 331 - 340 | 341 - 350 | 351 - 360

ALGER Villes principales

LADRAT Site de barrage

**Carte des accélérations horizontales de pointe pour la période de retour de 9950 ans.Region Centre**




*zone de accélération horizontale de pointe ( cm/s2))*

# CONCLUSION

1. The dams analyzed within this Project, in relation to the time when they were designed and constructed, mostly satisfy the current International and local Algerian Standards.
2. Method of operation of these dams was predominantly in compliance with the operation manuals and instructions.
3. The dams withstood even higher values of peak ground accelerations than the PGAs for which they were designed for.

# THANK YOU FOR YOUR ATTENTION !