

RECOMMENDATIONS FOR REGIONAL PLANNING OF THE  
PROVINCE OF CHLEF (EL ASNAM) AFTER REGIONAL  
RISK ANALYSIS

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SUMMARY

We will describe, in this paper, the principal steps which have been followed for the purpose of formulating a regional area plan for the future development of the province of Chlef (formerly El Asnam) which was stricken by a major earthquake in 1980. Analysis of the seismic risk is one of the major constraints for management of the area. A regional seismic risk study is presently in progress and although it is not yet complete, it is expected to provide essential information for land planners such as: historic seismicity maps, historic maximum intensities, and identification of active faults and areas prone to liquefaction and landslides.

PRESENTATION OF THE STUDY AREA

About 200,000 km<sup>2</sup> out of the area of Algeria (roughly one tenth) is seismic. Unfortunately the seismic zone coincides almost exactly with the most inhabited part of the country which also contains most of the economic structures. Small earthquakes are felt by the population many times each year and every ten years, approximately, the country experiences a destructive earthquake. However the area of Chlef is far more active seismically than any other area and has experienced during the twentieth century the highest destruction and loss of human lives. At least four significant events have shaken this area with increasing magnitudes during the last half-century (1922 - 1934 - 1954 - 1980). In 1954 and 1980 when the population was, respectively, 18,000 and 130,000, the earthquakes were magnitudes 6.5 and 7.3 on the Richter scale and killed, respectively, more than 1,600 and 2,700 persons.

The Chlef province is located approximately 150 km west of Algiers and extends from the Dahra mountains to the north to the Ouarsenis mountains to the south. The Dahra is culminating at 1,000 m (3,300 feet) and is dominating a hilly area of 700 m (2,300 feet) high, lowering slowly westward and southward to the Chlef valley. This valley, the bed of the Chlef river, is bordered on the south by the Ouarsenis mountains having a relief of 1,200 m (4,000 feet).

The area of Chlef, and more generally the Tellien Atlas, are linked tectonically with the alpine folding, well known for its very high past and present tectonic activity. From the geologic point of view, the Chlef

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valley appears to be an accumulation of marine or continental sediments of a few thousand meters depth, overlaying a very fractured bedrock. This area has experienced a very hectic evolution during geologic time and is a highly unsettled zone having a relatively high seismic activity (according to CNAAG, 481 shocks have been felt from 1953 to 1979, the magnitude of 12 of them being greater than 5).

From the economic point of view, Chlef is essentially a farming area endowed with a high irrigation potential and irrigation network. The valley, creating a natural channel from east to west, has established the province as connecting link between the two major economic poles; that of Algiers to the east and Oran to the west. The valley is the most important means of communication across this area with highways, railways, natural gas pipelines, and other lifeline systems located in the valley.

During the seventies, the area of Chlef has experienced a beginning of the industrialization process which accelerated the urban development of the major cities. Thus, the population of the city of Chlef has increased seven fold from 1954 (18,000 inhabitants) to 1980 (130,000 inhabitants).

#### SEISMIC RISK AND REGIONAL PLANNING

##### Summary of the situation in the province of Chlef in 1980:

##### 1. The Population:

About 1,000,000 persons (i.e. 5% of the entire population of the country), were living in this area. Thirty percent of this population were living in urban sites (95 towns). The urban network of the province was unbalanced since most of the towns (67%) were clustered in the valley along the main highway and the railroad. The five largest towns (Chlef, Khemis, Miliana, Ain Defla, Boukadir) are located on these communication lines.

##### 2. The Industry:

Because Chlef is primarily an agricultural area, few industries have been located in this province, except for the main towns. In this case priority has been given to large plants such as:

- cement plant in Chlef,
- brick production plant in Khemis,
- steel frame plant in Ain Defla,
- sugar refinery plant in Khemis.

##### 3. Lifelines and Transportation Network:

As noted above, roads and railways, were located to enhance the exchange from Algiers to Oran. They proved to be the determining factor for the development of the area; therefore, special

attention will be given in this paper to the transportation network, emphasizing the analysis of regional seismic risk.

#### 4. Dams:

Three dams are located near the area that has experienced the historical intensity (Fig. 1). They are:

- Oued Fodda, 20 km east of the main fault that ruptured during the 1980 earthquake,
- Sidi Mohammed Ben Aouda, 80 km west of the fault,
- Ghirb, 80 km east.

Three other dams are being constructed and three others are proposed for construction in the near future.

#### Preliminary data on the regional seismic risk:

A seismic microzoning study in the Chlef region was initiated in May 1983. This study encompasses: 1) evaluation of the seismic hazards of ground shaking, surface fault rupture, and earthquake-induced ground failure on a regional scale, 2) evaluation of the seismic hazards in the Chlef area on an urban scale, 3) implementation of the results of the study in terms of building codes, land use practices, and construction practices, and 4) transfer of technology. The seismic microzoning study is scheduled for completion in July 1984.

When this paper was written, the seismic microzoning study was still in progress. The complete set of information required for an accurate evaluation of the regional seismic risk was not available. However, preliminary information from the early phases of the seismic microzoning study and existing information (from CNAAG and others) provided the basis for maps that could be used for making a preliminary evaluation of the regional seismic risk and guiding regional planning. These maps include:

- 1) a map of historical seismicity giving the intensities of historical events since 1850 and magnitudes since about 1911. Although the historical record of seismicity is incomplete, this map shows that the larger events have taken place in the Dahra mountains and around the city of Chlef. Few events seem to have been located south of the valley (Ouarsenis) or east of the area (Khemis).
- 2) a map of maximum historical earthquake intensities representing the composite of isoseismal maps from historical earthquakes in the region. This map emphasizes the conclusions provided by the catalog and map of historical seismicity. It shows that the most hazardous area (intensities IX and X) is roughly a circle of 20 km radius, the center of which is located near the village of Beni Rached. This circle includes, in its southern part, the towns of Chlef and Oued-Fodda.

- 3) a map of lineaments derived from photogeologic investigations. This map shows lineaments which are produced by faulting as well as lineaments which are suspected to represent faults and require field investigations. The main active faults such as the Oued-Fodda fault, the Ouled Fares fault, the fault extending from Aboul Hassen to the town of Tenes, and others are shown on the map (Fig. 1).

Although the geologic and seismological information are still being synthesised at this time in order to prepare probabilistic ground-shaking hazard maps, this preliminary information can be used to guide the general trend for the regional development. Further geologic and seismological investigations may produce additional data which will be intergrated in the regional development approach; however, the preliminary guidelines for regional planning are not expected to be altered significantly from those described in this paper.

The proposed plan for regional development and land use:

ANAT, the national agency for territory management, is responsible for the regional development study of Chlef. It recently produced the first stage of its proposed approach to the problem of the redevelopment of Chlef. The major constraints were:

- the seismic risk,
- the preservation of farming lands, and
- urban development which balances urban expansion verses rural activities.

The future freeway which will cross the province of Chlef from east to west is another important factor in the redevelopment of the Chlef area. This freeway is expected to stimulate the whole economic life of the region and to enhance urbanization; therefore, the freeway becomes the keystone of the whole regional development plan.

Three variant solutions are proposed for the location of the freeway. The elements for each solution are described below (see Fig. 2).

First solution: The freeway crosses the province on the Dahra area (north of Chlef valley) from Khemis to Oued Fodda where it crosses with river then runs south of the town of Chlef and stays on the hills of the southern banks of the river.

Second solution: In this solution the freeway crosses the river sooner (at the level of Ain Defla) and follows the valley on the foothills of Ouarsenis until it reaches the west border of the province of Chlef.

Third solution: The freeway avoids completely the Dahra mountains and hence the zone of high seismic risk. It runs, from the very beginning, on the foothills of the Ouarsenis mountains avoiding both the rich alluvial valley and the zone of high seismic risk between the towns of Chlef and Tenes.

## RECOMMENDATIONS AND CONCLUSIONS

### Recommendations

The national authorities have provided overall guidance for the regional planners. In connection with the development of the province of Chlef, the recommendations of the national authorities include the following:

- A.1 - Restrain the urban development of the towns located in the Chlef valley.
- A.2 - Develop the agricultural activities on the foothills northward and southward.
- A.3 - Encourage the development of the small cities, located preferably on the foothills.
- A.4 - Encourage small and average-sized industries.
- A.5 - The freeway should avoid the valley.

We shall additional recommendations which incorporate the preliminary analysis of the seismic risk in the Chlef area:

- B.1 - Construction should avoid the alluvial terraces of the Chlef valley which are expected to represent the worst soil conditions.
- B.2 - Any construction, lifeline, or communication system should, when possible, avoid known or suspected active faults.
- B.3 - The development of the cities in the zones having the highest historical ground-shaking intensity (X and IX) should be severely controlled.
- B.4 - A thorough study of the seismic risk should be undertaken to provide guidance for the construction of Sidi Yacoub and Bouhallou, located near the zone of high historical seismic risk.

Some recommendations belong to both sets such as: A-1 and B-1, A-3 and B-1 with a restriction concerning the west Dahr foothills.

### Conclusions

Although the study of the regional seismic risk is incomplete at this time and all the geologic, seismological, geotechnical, and engineering data pertaining to the seismic risk in the Chlef area have not been fully assessed, it is possible at this time to propose preliminary general guidelines for the development of the Chlef province in terms of urban distribution, economic activities, and the network of lifelines and communication infrastructures. We think that the following steps will be followed by the regional planners:

1. Urban development: The cities of Chlef, Khemis, Ain-Defla, Boukadir should have a controlled growth; whereas, El Hassania, Tarik Ibn Ziad, Ouled Chorfa located south of the area should have an accelerated development.

2. Economy: The natural agricultural vocation of the area should be encouraged, especially in the valley and the northern foothills of Dahra. Industry should be developed in term of small units; large plants should be avoided.
3. Freeway: Variants 1 and 2 for the freeway should be discarded, being totally opposed to the recommendations to the planners made by the national authorities and the recommendations which incorporate the preliminary analysis of the seismic risk. Variant 3 should be adopted even though the direct cost of the freeway construction will be substantially higher than that for variants 1 and 2.
4. Construction of essential services: Civil protection buildings, hospitals, telephone centers should preferably be located outside of the zone of highest intensity. If this is not possible, their design and construction should comply strictly with the earthquake-resistant design provisions of the building codes. Nuclear plants and large strategic construction projects should be located outside of this province

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