

Climate Change

9 ASSESSMENT OF BIOCLIMATIC CHANGE AND VULNERABILITY (LEBANON CASE STUDY)

9.1 GOALS OF ASSESSMENT

The general target is to identify, under the predicted modifications in CO₂ levels and according to the IPCC-proposed climate change scenarios, the changes that would occur in the Lebanese climate. This study points out the probable modifications of the current bioclimatic levels, as changes in the principal climatic factors (e.g. precipitation, temperature...) reflect directly upon the distribution of those levels. It is possible, then, to outline the different bioclimatic vulnerability levels with or without the doubling, by year 2100, of the 1990-atmospheric concentration of CO₂.

9.2. SCOPE OF WORK

Our investigations cover the whole Lebanese territory. This is due to the fact that variations in the meso and microclimatic conditions exist all across the country and influence, to a great degree, the distribution, the structure and the species composition of the Lebanese terrestrial ecosystems.

As for the time frames, we settled for the following:

- Baseline scenario: taking into consideration that a 30-year average of meteorological observations is necessary the most appropriate, and available, time-serie was: 1940-1970.
- Climatic change scenario: according to the General Circulation Model and scenario that we adopted (*i.e.* HadCM2 / HHGGax) years 2020, 2050 and 2080 were chosen instead of the IPCC-proposed milestone years 2015, 2050 and 2100.

9.3. METHODS AND UNCERTAINTIES

The parameters that characterise the climate are numerous: precipitation, temperature, atmospheric humidity, winds, intensity and length of the drought period, potential evapotranspiration etc...

While conducting this study we were bound by a number of restrictions, namely:

- the very restricted number of synoptic climatic stations that produced complete thirty-year series of data,
- many of the remote stations were provided only by pluviometers,
- lack of time to undertake statistical calculations in order to fill the gaps in the actual data and,
- most of all, the unavailability of specific software and models specialised in the manipulation of such data.

In order to build up the different bioclimatic scenarios that reflect the predicted changes,

we had to draw first the baseline scenario. The most recent study of the Lebanese climate identifies six bioclimatic levels (Abi-Saleh, B. *Etude phytosociologique, phytodynamique et écologique des peuplements sylvatiques du Liban*. Thèse Univ. Droit. Econ. Sc. Aix-Marseille III. 1978; 184p.) Based on the same principles, each of the different stations was given a code according to the bioclimatic level in which it is located. Expert judgement was used in the case of stations that had only precipitation values, based upon analogue approach and taking into consideration relief and geographical parameters.

By gathering all the stations located in the same level, we managed to create the map of the bioclimatic levels. This map is considered to reflect the current Lebanese climate situation and the assumed fluctuations in absence of global warming. The chosen model / scenario for the Lebanese case study for Vulnerability Assessment to Climate Change is HadCM2 / HHGGax, according to which CO₂ emissions will continue to increase with an annual rate of 1%, leading to a doubling of the 1990 CO₂ level by the year 2060.

After identifying Lebanon's position according to the grid defined by this model we applied, for each station, the predicted modifications in precipitation and temperature values.

The same methodology and data analysis as for the bioclimatic assessment in the baseline scenario was then applied. Consequently, we came up with the maps relative to the bioclimatic levels that would be observed under these new climate conditions.

Respective area percentage of the Lebanese territory, covered by each of the identified bioclimatic levels, in each of the above-mentioned maps, is shown in the table hereafter:

Bioclimatic level	Baseline scenario	Climate change scenario		
		Year 2020	Year 2050	Year 2080
Extreme arid	—	—	—	2.762
Arid	4.856	4.919	4.920	13.270
Semi-arid	19.321	23.838	23.871	15.223
Subhumid	45.166	49.575	50.652	60.757
Humid	25.903	19.728	19.442	7.470
Perhumid	4.522	1.765	1.115	0.518
Oromediterranean	0.232	0.175	—	—

9.4. VULNERABILITY ASSESSMENT

The assessment of bioclimatic vulnerability must take into account the interaction between all the climatic factors that contribute to the definition of the climate and the bioclimatic levels. In our case, *i.e.* the Mediterranean climate, the evaluation of the degree of vulnerability can be based on the study of the two principal *limiting factors*: *period of drought* and *risk of frost*. The vulnerability to climatic modifications becomes greater when these factors increase in value or in intensity.

However, some precautions are to be taken while doing this analysis. For every

bioclimatic level, the different climatic parameters are included into bracket values. Due to a decrease in precipitation amounts, a given zone could become included in a “drier” level; however, its degree of vulnerability would remain unchanged if the observed decrease does not exceed the lower limit of the corresponding level.

At this point of the study we can say that the most bioclimatic vulnerable zones are the levels that are the most humid and cold ones, the areas that lay under severe drought conditions and also the regions where a “climatic warming” would occur within the high altitudinal ranges, *i.e.* > 1500 m.

On the other hand, a medium degree of vulnerability can be given to the areas submitted to changes that will induce their crossing to the closest level, especially in the medium altitudinal ranges, *i.e.* from 500 m up to 1000 -1500 m.

All other areas would be classified under a low vulnerability degree, particularly where no changes in the distribution of the bioclimatic levels have occurred. The chronology of these changes is shown on the enclosed map.

9.5. CONCLUSION

As a result of this study, we can make the following comments:

- The predicted changes in climatic parameters, *i.e.* decrease in precipitation amounts combined with an increase in temperature values, reflect clearly on the spatial distribution of the bioclimatic levels.
- The decrease in area coverage, for a given bioclimatic level, is frequently accompanied by a fragmentation of the initial area. On the other hand, an increase in such coverage results in joining separate regions under one geographic and bioclimatic zone.
- Another relevant fact consists in the individualisation, in year 2080, of a new bioclimatic level EXTREME ARID, characterized by a twelve-month period of drought, and in the disappearing of the OROMEDITERRANEAN level along milestone-years 2050 and 2080.
- Variations are also observed through the latitudinal and longitudinal shifting of the boundaries of these bioclimatic levels.