10 Response of Italian Glaciers to Climatic Variations

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10.1 Introduction

The glaciers of the southern alpine slope have been investigated using a variety of different methods. The most common ones are:

a) glacial inventories, which consist of an overall description, the geographical location, the classification, and the area and volumetric measurements. Four such inventories, all focussed on the Italian Alps, were carried out in 1925, 1958, 1976 and in 1989 [1,2]. The first one is the result of the consultation of I.G.M. topographic maps, the second comes from measurements in the field, and the latter two come from aerophotogrammetric observations. The data base for the last one was provided by Italy Flight 1988;

b) annual glacial campaigns, during which snout variations of the ablating tongue are measured. The operation, carried out by land surveys, refers to a sample of about 15% of the total population of glaciers, and it includes almost all the glacial bodies of major dimension and importance [3];

c) mass balances, with the calculation of the volumetric variation of the glacier in time and its role in the local climatic evolution. Only a few sample glaciers, located in different parts of the Alpine range, are taken into consideration.

10.2 Glacial Inventories

The inventory of 1989 (Table 10.1) includes 706 glacial bodies with a surface larger than 0.05 km$^2$ (a dimension limit recommended by the World Glaciers Inventory). Figure 10.1 shows the distribution according to the historical division of the Alps. In addition to these bodies, there are others with a surface area less than 0.05 km$^2$, mostly of the type called glacionevato [4] and a collection of glaciers that were extinguished during the past 100 years, but whose history is known. From the comparison with the inventory of 1958, one concludes that the number of minor and extinguished glaciers is increasing, while that of glaciers with a surface area exceeding 0.05 km$^2$ is decreasing. Moreover, the total glacial area has shrunk by 8.2%. It should be noted that the comparison is only suggestive, given the different methods adopted for the two inventories.

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1 A glacionevato is “a more or less homogeneous and compact mass, formed by snow and/or ice, of different extension and form, that lasts for two or more years and is not in motion” [4]. It differs from a glacier because the latter moves slowly [5].
Table 10.1. Variation of the number and surface of glacial bodies in the Italian Alps.
The comparison refers to the data of the inventory of 1967–68 (normal typeface) and to those of the inventory of 1989 (bold)

<table>
<thead>
<tr>
<th>Glacial bodies</th>
<th>Extincted</th>
<th>Surface less than 0.05 km$^2$</th>
<th>Surface exceeding 0.05 km$^2$</th>
<th>Total area in km$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Western Alps</td>
<td>41 → 90</td>
<td>15 → 36</td>
<td>307 → 272</td>
<td>363 → 398</td>
</tr>
<tr>
<td>Central Alps</td>
<td>108 → 117</td>
<td>35 → 28</td>
<td>220 → 243</td>
<td>363 → 388</td>
</tr>
<tr>
<td>Eastern Alps</td>
<td>52 → 100</td>
<td>40 → 36</td>
<td>217 → 191</td>
<td>309 → 327</td>
</tr>
<tr>
<td>Apennines</td>
<td>–</td>
<td>0 → 1</td>
<td>1 → 0</td>
<td>1 → 1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>201 → 307</strong></td>
<td><strong>90 → 101</strong></td>
<td><strong>745 → 706</strong></td>
<td><strong>1036 → 1114</strong></td>
</tr>
</tbody>
</table>

10.3 Glacial Campaigns

The graph in Fig. [10.2] shows the glacial snout variations, expressed as a percentage of advancing glaciers, for the sample measured from 1925 to 1998. The series contains an interruption of four years, from 1943 to 1946. The data show that, until 1965, only about 10% of the measured glaciers were advancing, while the great majority of glacial bodies showed a regression. Between 1966 and 1980 there were large annual variations, but in general the percentage of advancing glaciers increased significantly, including about 80% of the observed bodies. In the last twenty years, there was again an increase of the number of regressing glacial tongues, that led to values comparable with those measured in the period before 1965. Based on these measurements, and on the comparison with