SPATIAL CHARACTERISATION OF TERRAIN UNITS IN THE BOTTELARYBERG-SIMONSBERG-HELDERBERG WINE GROWING AREA (SOUTH AFRICA).

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Introduction

The first South African wine was made by Jan van Riebeeck on the second of February 1659. His initial determination to produce wine at the Cape refreshment station was continued by other governors resulting in improvement and expansion of the embryo industry. As the colony opened up and new areas were discovered, so the wine industry developed to its present extent of over 100 000 ha (SAWIS, 1999). The initial expansion was based on ease of access and mainly focussed on fertile valleys, with rivers to provide irrigation in the more arid regions. Yield was often the overriding factor considered. However, when over-production became a problem in the early twentieth century, the focus was moved to quality. This eventually resulted in the introduction of the Wine of Origin legislation in 1973. South Africa is, therefore, a relatively young wine-producing country and has little tradition or experimental data to support delimitation of areas of origin. Such areas are demarcated on application by the producers. Natural factors, such as landscape, soil and macroclimatic patterns are used to determine boundaries, after which these demarcated areas are allowed to develop to express their specific wine style and character instead of proving their originality beforehand (Saayman, 1998). The identification and spatial characterisation of terrain units will act, therefore, as a scientific basis for the delimitation of areas for the production of characteristic wines of high quality. It will also provide an important basis for future development and management decisions and enable South Africa to remain competitive in an ever-expanding international wine market.

Description of the study area

The South Western Cape, where the majority of the South African vineyards are situated, has diverse climatic and soil environments due to the topography of the region. A study area of approximately 25 000 ha has been delimited in the Bottelaryberg-Simonsberg-Helderberg wine growing area (Figure 1), to the south east of Stellenbosch, to establish and test the methodology for the identification and characterisation of viticultural terrains, and will be examined in greater detail. The Stellenbosch wine growing area contains 15.5 percent of the country's vineyards with the predominant cultivars being Chenin blanc, Sauvignon blanc and Cabernet Sauvignon. A narrow coastal plain is bordered by the NW-SE mountain ranges of Helderberg (1137m) and Simonsberg (1390m) and indented by the SW-NE Bottelaryberg (520m). The Eerste River bisects the study area. This topography results in a large variation in aspect and altitude and affects the airflow in the region. Two predominant currents, the cold Benguela current along the west coast and in Table Bay and the warm Agulhas current along the south coast and in False Bay, play an important role in the climatic patterns of the area.

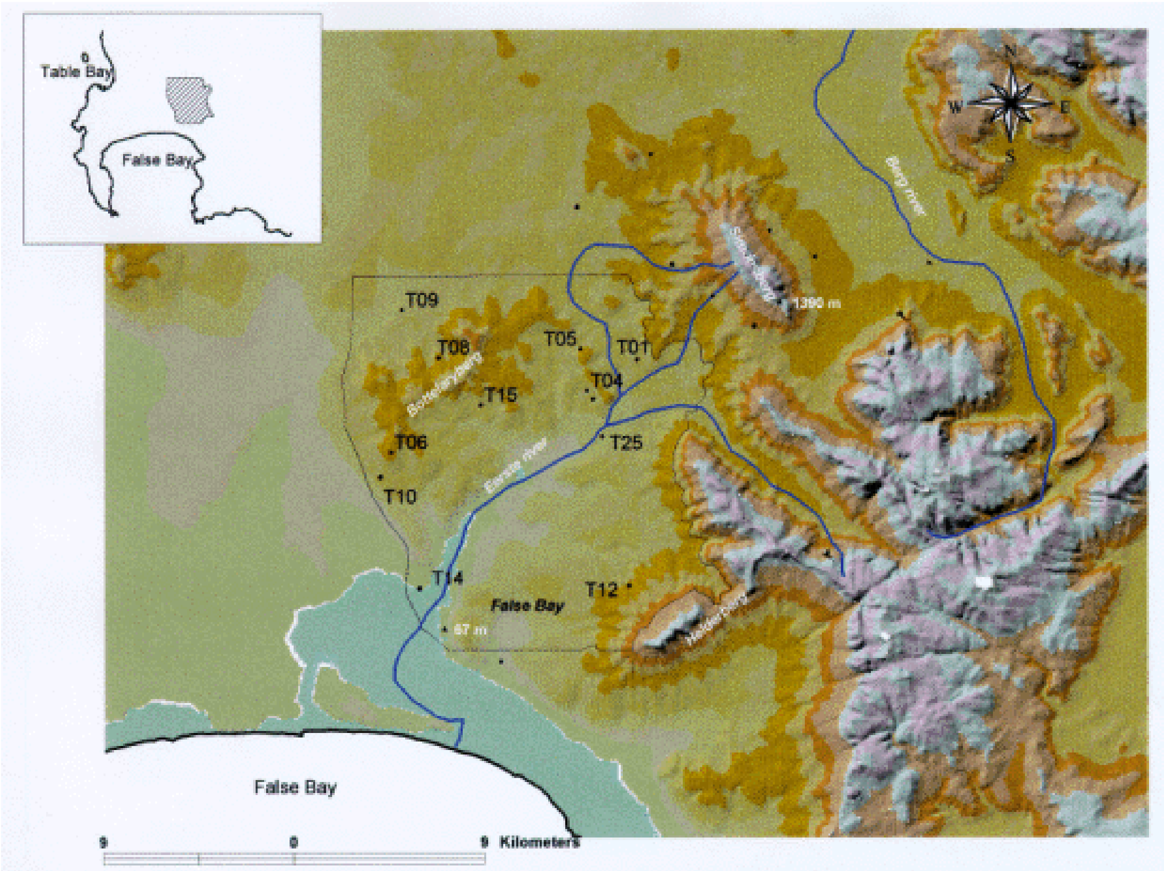


Figure 1.
Position of Bottelaryberg-Simonsberg-Helderberg study area in relation to the coastline and other topographical features. Weather stations are shown as Tn.

Climate

There is a network of eleven weather stations on various landscape positions in this study area (Table 1). Using the average data from the weather station network and the description of Peguy (referred to in Tonietto, 1998), the climate of the area can be described as Mediterranean. It has a predominant winter rainfall with the summer rainfall for the period of December, January, and February being less than one sixth of the annual rainfall. The coldest month has a mean temperature lower than 15°C and at least eight of the monthly mean temperatures are greater than 10°C (Figure 2). However, according to Kendrew (1961), it is cooler than similar latitudes and altitudes in the Northern Hemisphere. Using the global climatic classification of Tonietto (1998), the study area has a warm temperate climate with no heliothermic constraints for the ripening of cultivars. The temperate nights can be expected to cause later ripening cultivars to ripen under cooler night time conditions than earlier cultivars. The pronounced drought period (December to February)generally requires irrigation of the vineyards. This classification places the study area in the same group as Madrid (Spain) and Evora (Portugal).

Table 1 shows that there are noticeable differences between the stations with respect to climatic data, despite their proximity geographically. Mean February Temperature (MFT) is an index used by De Villiers *et al.* (1996) to describe the climatic potential of the South Western Cape for viticulture. A difference of 1.8°C can be noted between T10 and T25. This difference is due mainly to the difference in distance from False Bay and aspect of the two stations. T10 has the lowest number of hours above 30°C for the period of December to March. It is close to False Bay and therefore experiences the modifying effect of the sea breeze. The stations situated the furthest away from the two oceans (T01, T04, and T05) experience higher thermal amplitude and more hours below 12°C and above 30°C for the period December to March. Rainfall for the growth season and the dormant period also differs between stations.

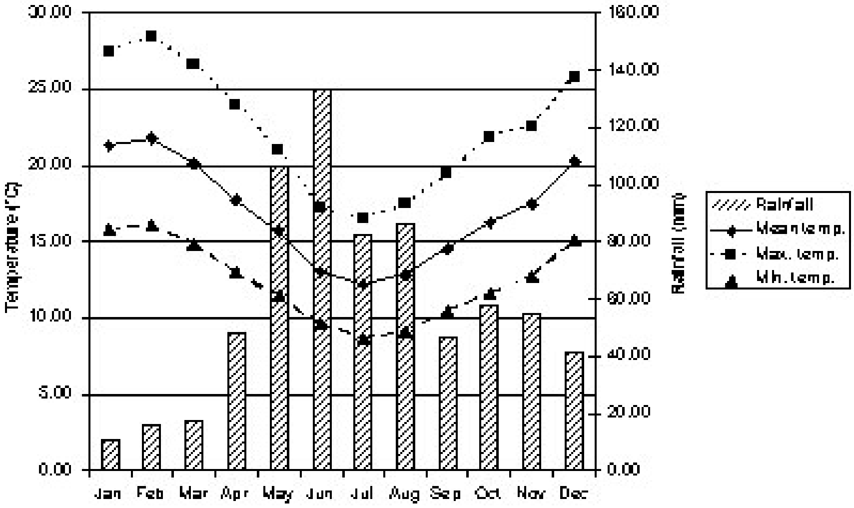


***Figure 2**. Mean monthly temperature and rainfall values averaged for 11 weather stations in the Bottelaryberg-Simonsberg-Helderberg study area for the period 1995 to 1999. Mean average temperatures for all the months are higher than 10°C and the mean temperature of the coolest month is lower than 15°C. The sum of the rainfall for December, January and March is 68mm. The annual rainfall is 702mm.*

Table 1. Climatic data from the weather station network in the Bottelaryberg-Simonsberg-Helderberg wine-growing region (South Africa) for the period 09/1995 to 04/1999.

Weather station	**Altitude**	**Aspect**	**MFT °C**	**Hours >30°C (Dec — Mar) hrs**	**Hours < 12°C (Dec — Mar) hrs**	**Rainfall (Sep— Mar) mm**	**Rainfall (Apr — Aug) mm**
T01	148	SW	21.79	147	61	255	455
T04	148	NW	22.14	220	67	249	498
T05	210	WNW	21.51	172	72	218	395
T06	250	ESE	21.02	183	34	243	444
T08	235	N	21.22	118	35	222	407
T09	110	N	21.85	192	38	213	479
T10	130	SW	21.01	108	23	201	320
T12	225	NNW	22.36	197	21	301	526
T14	27	S	22.04	197	21	213	396
T15	153	S	22.09	158	39	323	617
T25	92	NNW	22.78			246	487

The summer winds are generally southerly, south-westerly or south-easterly (Figure 3) while strong northerly, north-westerly or north-easterly winds occur in winter. The mountain ranges in the South Western Cape cause the winds to blow along rather than across the coast, increasing their velocity, and the proximity to the sea results in interplay between land and sea breezes. The synoptic circulation at altitude as well as topography (aspect) on the surface affects the predominant wind direction and wind speed. Weather stations open to and facing the sea experience strong winds more often than those that are sheltered (Figure 3). Studies by Valerie Bonnardot (personal communication) showed the important effect that the sea breeze can have on maximum temperature in the vineyards during February, when most grapes ripen. It results in cooler day temperatures. The area surrounding Stellenbosch, and therefore this study area, is affected by the sea breeze circulation from the south, south-west and west and therefore has the benefit of cooler temperatures. Differences depend, however, on distance from the sea and on aspect. Stations facing north and north-east are more or less sheltered from the sea breeze and although the sea breeze may reach the station, it is not as effective (in terms of wind speed and cooling effect) as at stations open to and facing False Bay.

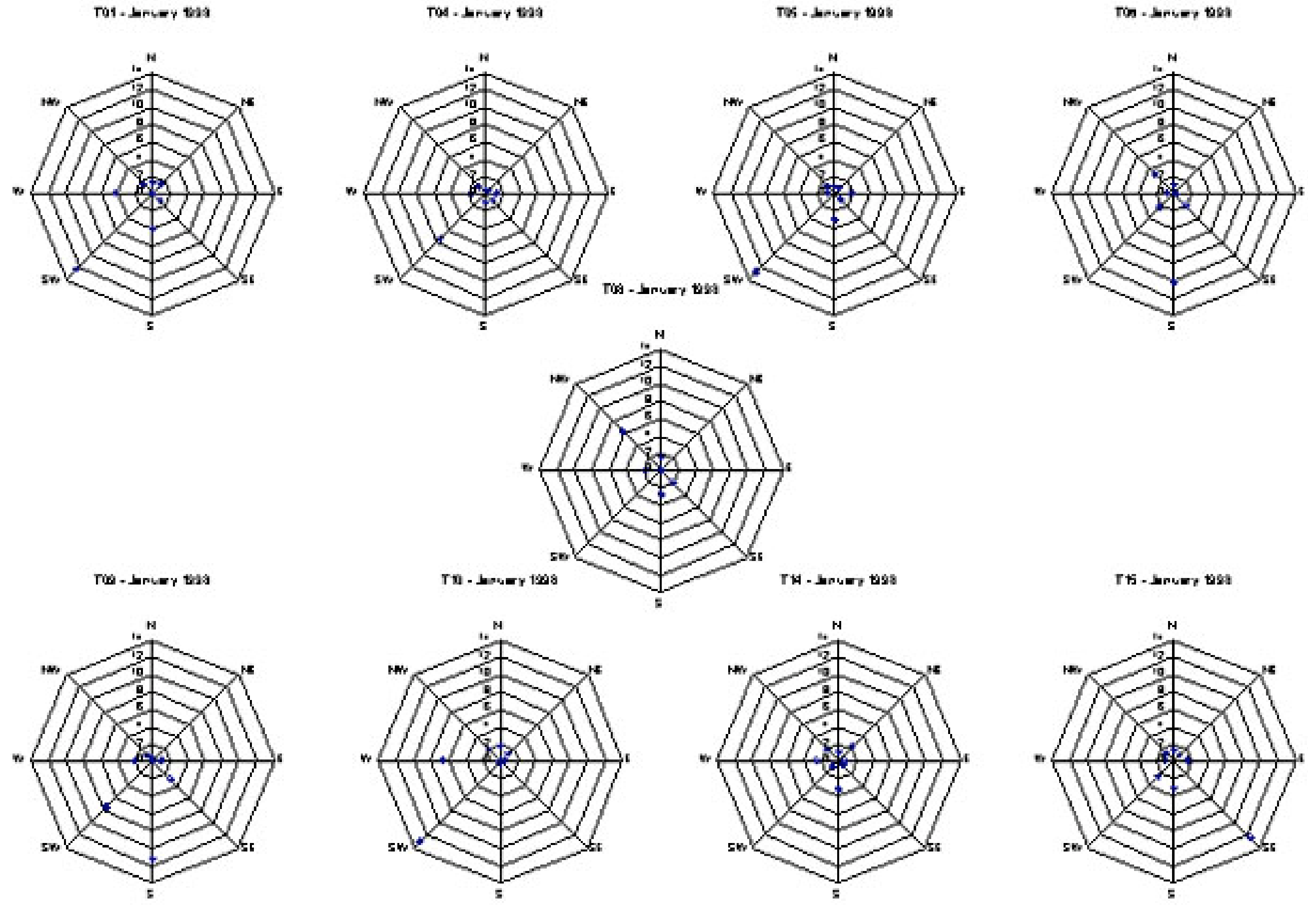


Figure 3.
Wind directions and wind speeds during January 1998 measured by weather stations in the Bottelaryberg-Simonsberg-Helderberg study area

Geology

Rocks of the coastal plain belong to the Malmesbury group (1000-632 Ma), which includes shales, phyllite and greywacke. The pile of sediments was compressed into tight folds during orogeny and the rocks are therefore susceptible to weathering and erosion. Granite intrusions occurred during the Cambrian period (600 —400 Ma). Around the contact with the granite, the rocks of the Malmesbury group were baked resulting in hornfels. Erosion levelled the resulting mountain land to sea level and further subsiding of the land allowed the deposition of the Cape Supergroup sediments (600 — 425 Ma). The sandstones and shales of this Cape Supergroup, which originally covered the coastal plain, have mostly eroded away leaving remnants such as the Cape Peninsula and Simonsberg (Anon). Alluvium is found in the river and stream courses, much of which would have a Table Mountain sandstone origin. Quartenary sediments and soils are also present throughout this region (Van Schoor, 1999). The geology of the South Western Cape is, therefore, complex. *In situ* weathering of rocks is seldom the only source of soil formation and mixing of parent material can be considered as important (Van Schoor, 1999).

Soils

Alluvial soils, mainly derived from Table mountain sandstone, are present along the courses of the Eerste and Bottelary Rivers. Red and yellow mesotrophic to distrophic neocutanic and apedal soils are found mainly on the footslopes of the Bottelaryberg, Simonsberg and Helderberg. These soils are generally derived from granite parent material. Small areas of residual soils are present while duplex soils are found, generally, in lower lying areas. The soil form changes over a very short distance, as was shown by Conradie (1998). Within one vineyard (no more than 60 meters apart), soil colour and degree of structure and drainage differed markedly. In spite of widely varying effective soil depths due to various limiting factors, current deep soil preparation practices can, to a large extent, overcome depth limitations. Also supplementary irrigation is widely practised. When judiciously applied, it can reduce water stress to levels promoting quality wine production. Soil surveys performed until now have resulted in maps on a scale of 1:250 000. New soil forms have been introduced and old ones reclassified since these studies. At present, soil data can, therefore, not form the basis for terrain identification in this study area.

<u>Characterisation of terrain units</u>

As can be seen from the above description, the environmental situation in the Bottelaryberg-Simonsberg-Helderberg wine growing area is complex.

There is an old adage that says that the best wines are made within sight of the sea and it appears that the degree of maritime effect has an influence on wine character in this area. This is mainly due to its effect on temperature, which, in turn, is affected by altitude and aspect. The degree of influence of the soil has not yet been fully determined but the effects appear to be related to the degree of water stress induced during a specific season when dry land viticulture is practised (Conradie, 1998). From the climatic information, the importance of the aspect and altitude with respect to temperature and airflow has been clearly seen. These factors should therefore form the basis of terrain identification and characterisation in the study area.

In a landscape, terrain morphological units can be identified (Figure 4). They are the crest, scarp, midslope, footslope and valley bottom. Most vineyards are found on the midslopes and footslopes. These have been mapped by means of a Geographic Information System (Wallace, personal communication) (Figure 5a) to provide base units for further characterisation. A 50m Digital Elevation Model (DEM) has been used to determine North-South aspect (Figure 5b) and altitude (Figure 5c). This data will be linked to the terrain morphological units. Once similar units have been grouped, they will be divided according to existing soil and geological data to obtain viticultural terrains. Due to the importance of the sea breeze for the vineyards in the study area, a Regional Atmospheric Modeling system (RAMS) will be used to perform sea breeze numerical simulations. This data will also be used to assist in the identification of terrain units.

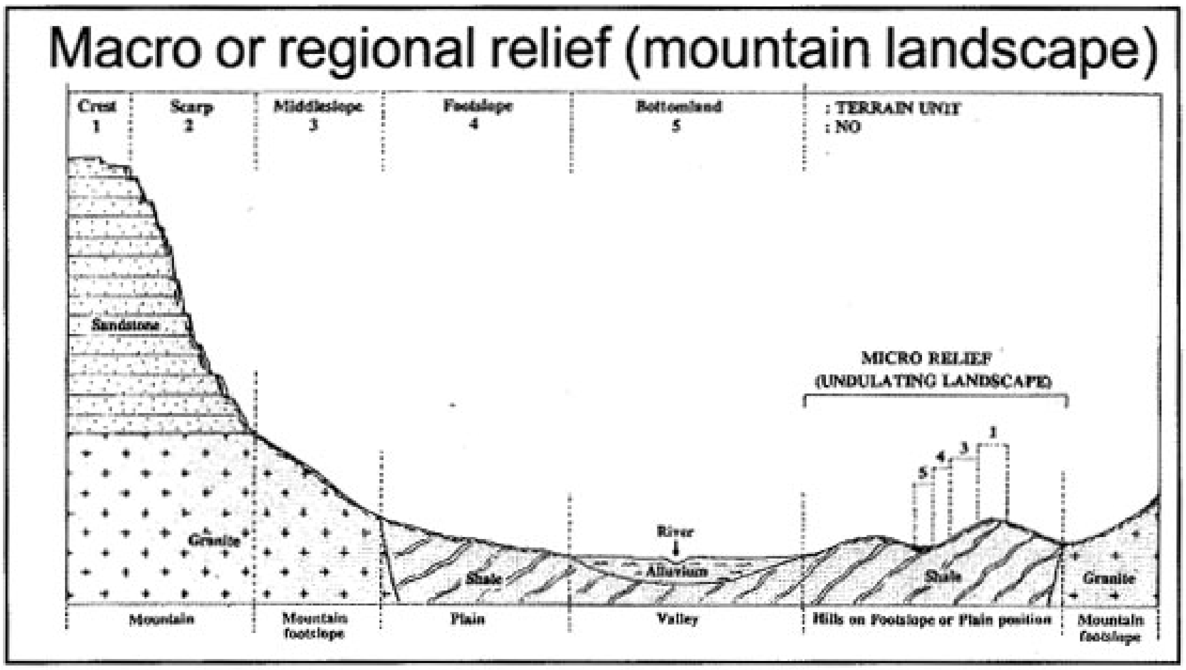
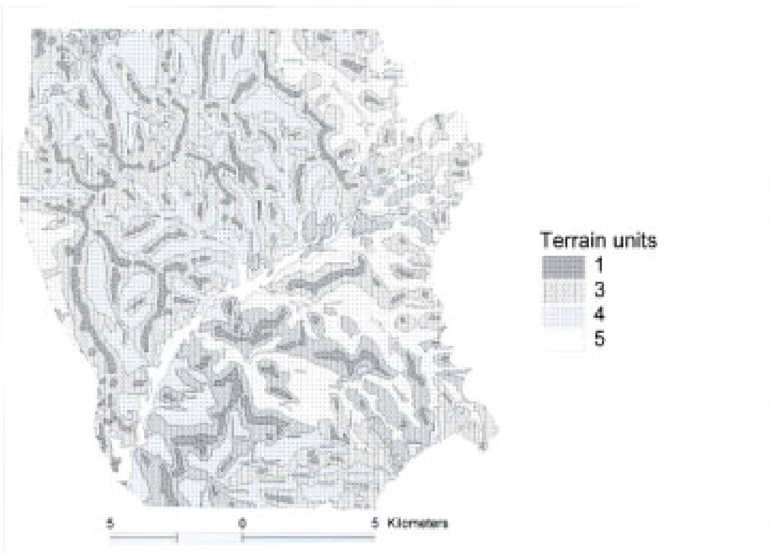


Figure 4. Terrain morphological units and typical geology for the area around Stellenbosch and Paarl (Saayman, 1998).

A network of experimental plots, linked to the weather station network, where viticultural data is being gathered and small scale wines made in order to determine the wine aroma profiles already exists. This data will be linked to the identified viticultural terrains. The terrain units will then be able to form the scientific basis for demarcation of areas of origin and will provide an important basis for future development and management decisions.

Figure 5.

a.



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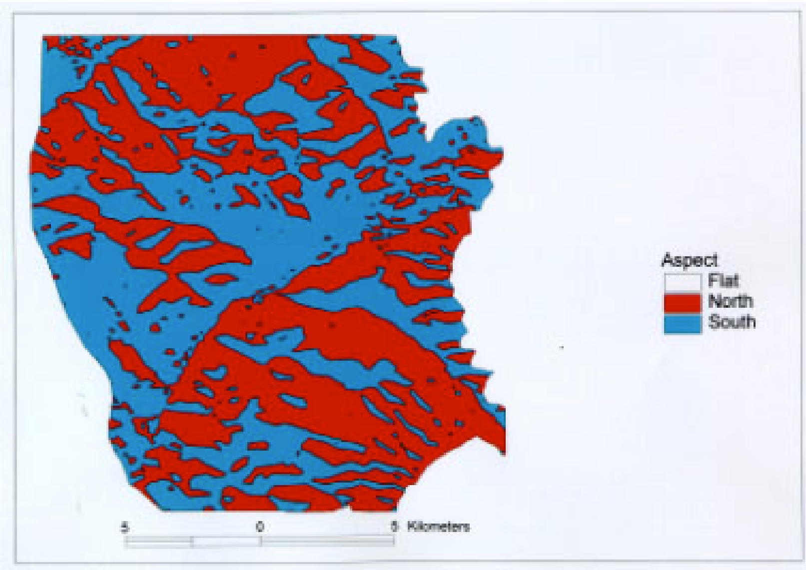

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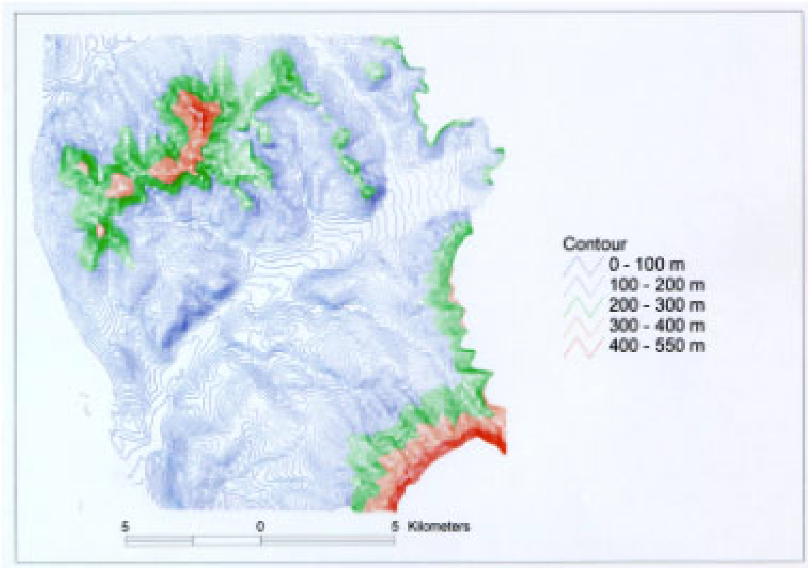

Figure 5.
Topography of the Bottelaryberg-Simonsberg-Helderberg study area. terrain morphological units, b. North-South aspect, c. altitude.

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