FROM LOCAL CLASSIFICATION TO REGIONAL ZONING - THE USE OF A GEOGRAPHIC INFORMATION SYSTEM (GIS) IN FRANCONIA / GERMANY. - PART 2: REGIONAL ZONING OF VINEYARDS BASED ON LOCAL CLIMATIC CLASSIFICATIONS.

DE LA CLASSIFICATION LOCALE AU ZONAGE REGIONAL - UTILISATION D'UN SYSTÈME D'INFORMATION GÉOGRAPHIQUE (SIG) EN FRANCONIE / ALLEMAGNE. 2ième PARTIE: ZONAGE REGIONAL DES VIGNOBLES SUR LA BASE D'UNE CLASSIFICATION CLIMATIQUE

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ABSTRACT

The climatic valuation of vineyards and viticultural regions in the northern hemisphere has a high importance for the cultivation of grape varieties with different ripeness development. A large amount of different information have to be compiled and analysed to work out the optimal locations for grape varieties with different ripeness periods within specific areas. New computer software such as a Geographic Information System (GIS) enables the detailed recording and analysis of viticulturally relevant factors.

One of the objectives of the GIS application in Franconia / Germany is the climatic classification of vineyards and the establishment of a climatic zoning. The main aspect of the climatic valuation is the sum of the direct radiation on vineyard sites. The local climate in northern viticultural regions is mainly influenced by local variations of slope and exposition.

By means of digital terrain models based on topographic maps, slope and exposition are calculated with the GIS. A combination of these factors enables the creation of maps with many small-scaled areas, each showing specific slope and exposition. From this, numerous larger zones with equal slope and exposition are deduced which receive the same amount of energy.

The calculation of the amount of radiation, especially for the months of ripeness, enables a local climatic zoning and delimitation of areas in Franconia / Germany suitable for viticulture. Based on the climatic classification, the endangering of areas by cold air and frost and the

frequency of fog can be also included into this valuation. Proceeding from the local climatic classification, regions or zones of equal climatic conditions can be clearly determined.

RESUME

En raison des variations locales d'exposition et de déclivité, l'évaluation climatique des vignobles et des régions viticoles est très important pour la culture des raisins. De nombreuses informations différentes doivent être réunies et analysées afin de trouver la position optimale pour des cépages avec des périodes de maturité différentes qui ensuite déterminent la région. De nouveaux logiciels, tel qu'un Système d'Information Géographique (SIG), permettent d'enregistrer et d'analyser en détail les facteurs importants.

L'un des objectifs d'une application du SIG en Franconie / Allemagne est une classification climatique des vignobles et l'introduction d'un zonage climatique. La somme de la radiation directe se situe au centre de l'évaluation climatique des surfaces viticoles, car elle détermine la quantité de chaleur reçue par une position. Ceci varie avec les conditions de relief, calculées à l'aide d'un modèle de terrain digital sur la base des cartes topographiques. Dans ces conditions, il est possible de constituer des cartes d'inclination et d'exposition. On peut en conclure que les zones de même déclivité et d'exposition reçoivent la même insolation.

Le calcul de la somme de radiation, particulièrement pendant les mois de maturité, permet un zonage climatique local et la délimitation des surfaces en Franconie aptes à la viticulture. Sur la base de la classification climatique, la quantité d'air froid, le risque de gel ainsi que la fréquence du brouillard peuvent être inclus dans l'évaluation. Partant de cette évaluation locale du climat, les régions de même clémence de climat peuvent être clairement délimitées.

INTRODUCTION

In recent years the application of Geographic Information Systems (GIS) was established as a helpful tool in different fields of research, consultation and service. Also in viticulture a GIS is used in order to acquire and display clearly arranged, complex connections and relationships between various viticulturally relevant factors. These GIS data can be used in various fields of application in viticulture (see KÖNIGER, SCHWAB & MICHEL in this volume) Besides soil conservation (see SCHWAB, KÖNIGER, MICHEL in this volume) in a viticulture information system for Franconia (Bavaria/Germany) especially the climatic classification of vineyards should be considered. Such a classification of vineyard sites helps to evaluate the vineyards with regard to the climatic influence on the quality of the grapes (HOPPMANN 1999). With the aid of a three-dimensional terrain model it is possible to "map" frost endangered areas and to create insolation maps, the basis of a climatic classification. With help of the GIS data, local information on the selection of suitable grape varieties, plant protection or irrigation planning can be specified. Consequently, the viticulture information system is an efficient tool in consultation and research for an improvement of the vineyard management.

THE IMPORTANCE OF TOPOCLIMATE IN VITICULTURE

One of the most important influencing factors within a vineyard site is the topoclimate, which, among other factors, specifies significantly the selection of a suitable vine variety. This spatially limited mesoclimate determines the phenological stages from the beginning of the vegetative period and may extend locally the vegetation and ripeness period.

Therefore, 90 % of the variation in grape quality is based on the variability of climatic factors such as insulation, temperature, evaporation, precipitation and the water availability during vegetation period (HOPPMANN 1999).

The topoclimate is controlled by these climatic factors and influences the viticultural site together with topography and soil (Fig. 1). The climatic classification of viticultural sites plays an important role in the cultivation of grape varieties with different ripeness periods due to exposition (aspect) and inclination (slope) variations at short distances.

Considering different areas, it is obvious that in Franconia vineyards exposed to the south do not receive the highest charge of energy in summer time but show a distinct radiation profit in spring and autumn (HÄCKEL 1999). Therefore the cultivation of vines on steep slopes and with an exposure towards south benefit from a higher and longer energy input during ripening, a longer period of ripeness, an earlier bud break and less danger of frost.

The main objective of the climatic classification is the computation of the direct radiation on vineyards because it controls the temperature condition of a site and it is independent of the soil conditions (HOPPMANN & LÖHNERTZ 2002).

Especially in Franconia insulation and water balance play the leading role in quality improvement. Many profitable vineyards are located on shell limestone with a poor water retarding capacity which increases the occurrence of drought stress of vines in summer time.

GIS-REQUIREMENTS AND PREPARATORY WORK

Based on topographic height information of digitized contour lines a three dimensional terrain model has to be created with a GIS (see KÖNIGER, SCHWAB, MICHEL in this volume). Therefore a GIS tool is necessary which is able to compute a relief model (e.g. 3D-Analyst for ArcView). Such models are used to create different themes ('layers') with topographic information like slope degree.

For a climatic classification it 's necessary to generate aspect and slope maps which are the most important factors for the amount of insulation. An intersection of aspect and slope with the GIS generates a new theme to deduce zones with equal slope and aspect that receive the same amount of energy.

CREATION OF A CLIMATIC CLASSIFICATION

With the aid of different climatic computer models, it is possible to calculate the particular short wave radiation (global radiation) per day. At first the sunshine duration for every location depending on the angle of inclination and orientation has to be computed. In combination with the geographic coordinates, these data are used to calculate the global radiation for every day of the year.

The global radiation is divided into direct insulation and diffused radiation. Their ratios can be estimated approximately to determine the direct insulation as a factor for the evaluation of the temperature condition of a vineyard site.

The particular direct insulation is assigned to the zones of equal slope and aspect created by intersection (Fig. 2) By means of the results for every possible combination, a classification in five classes is possible with the aid of a GIS which enables the generation of detailed maps of a climatic classification of vineyards. This allows a regional division of climatic zones.

Within this classification cloudiness and sky view factor are not yet considered. An average sky view factor for every slope should only be considered if the radiation values are available for all vineyards. For Franconia cloudiness is not yet considered at the moment. Cloud cover is assumed to be equal for the entire viticultural region of Franconia and therefore can be neglected in the climatic classification.

The most promising differentiation of the climatic suitability of vineyard sites in Franconia is to compare the sum of the direct radiation during the period of ripeness in September and October. With increasing inclination of slopes, the difference of the insulation between areas with an exposure towards south or west / east also increases (Fig. 3). A plain vineyard site will get a high amount of insulation during the vegetation period but far less in the ripeness period.

A classification based on the amount of insulation is the first, but most important step for a general classification of the Franconia vineyards. By using the three dimensional terrain model it is possible to 'map' frost endangered areas like valleys and depressions and to determine flow-off paths of cold air. In addition the climatic factors like temperature, rainfall distribution, evaporation and frequency of fog will be included in the GIS in the future.

CONCLUSION

The calculation of the amount of radiation, especially for the months of ripeness, enables a local climatic zoning and the delimitation of areas in Franconia / Germany suitable for viticulture. Based on the climatic classification, the endangering of areas by cold air and frost and the frequency of fog can be also included into this valuation. Following the local climatic classification, regions or zones of equal climatic evaluation can be clearly described.

This climatic classification in combination with a GIS delivers a scientific basis for a 'terroir'-model in Franconia. Scientists and consultants can use the assessment of vineyards as a tool for the planning of new plantings and a quick and profound valuation of vineyard sites to obtain a higher profitability.

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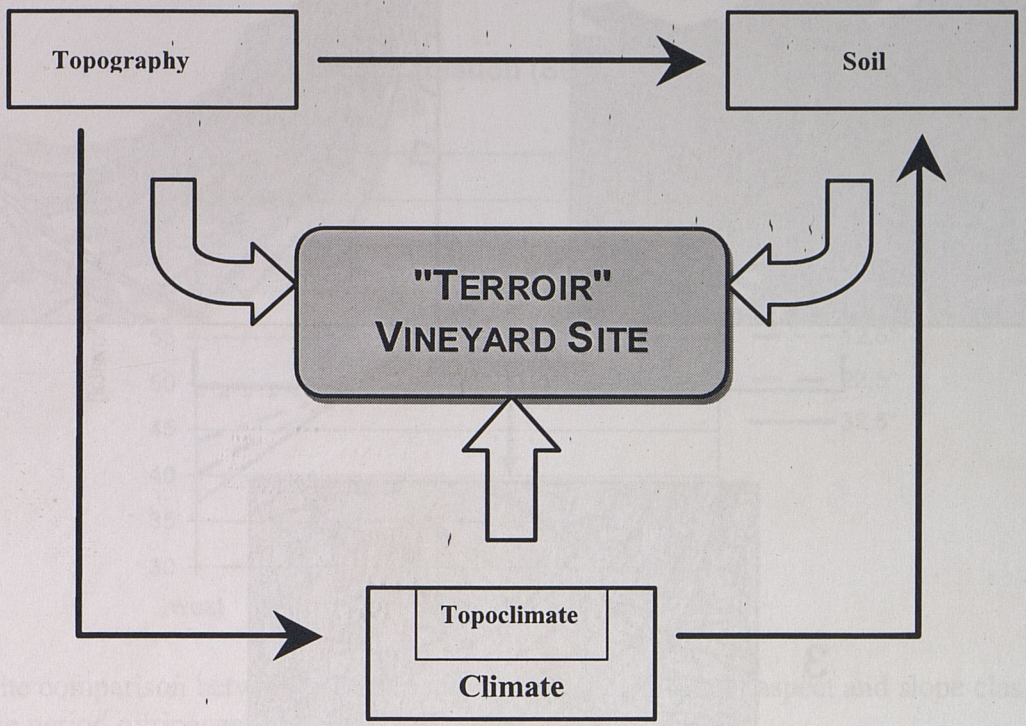

Fig. 1: A vineyard site is determinated by topography, soil and topoclimate. The three factors are also in relation to each other and do create the 'terroir' of a vineyard site.

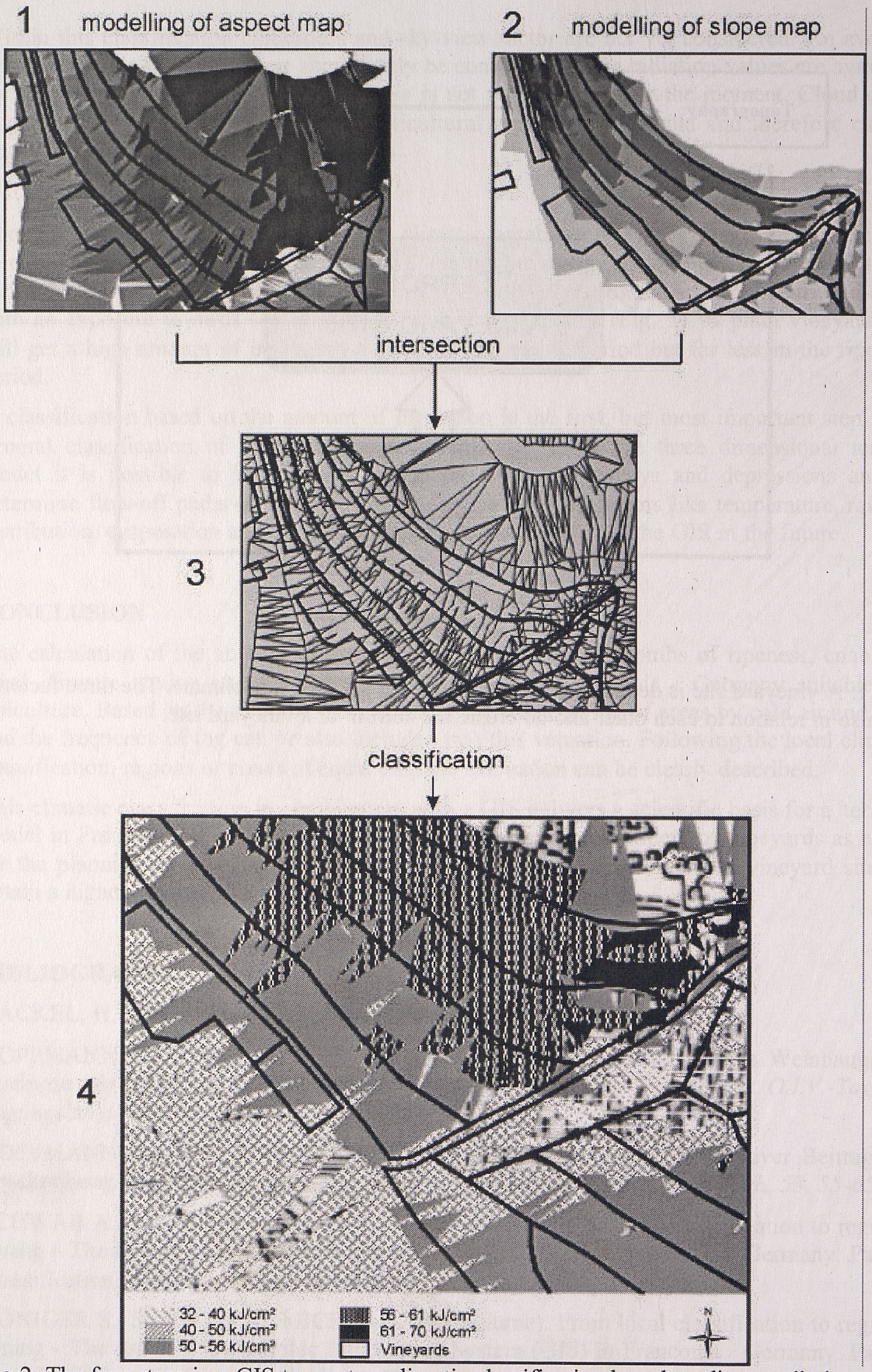

Fig 2: The four steps in a GIS to create a climatic classification based on direct radiation during the period of ripeness (September and October)

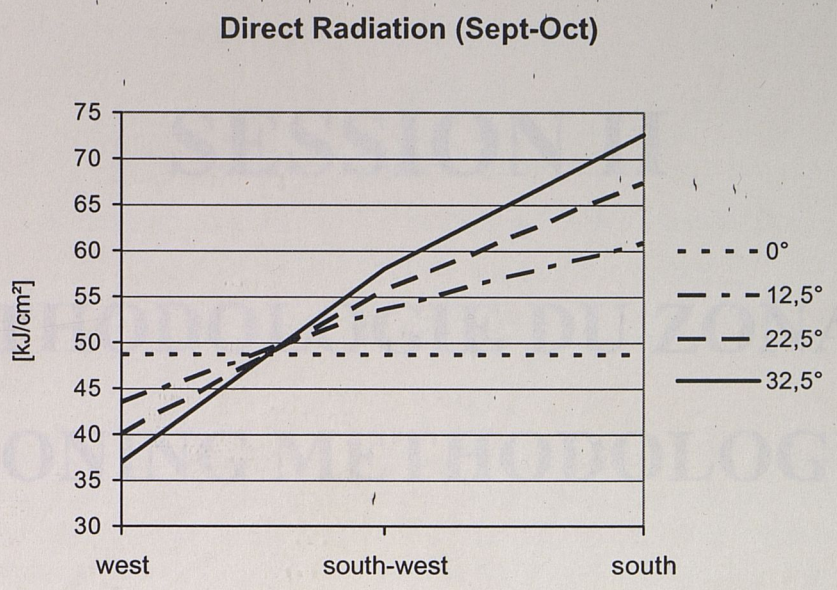

Fig. 3: The comparison between the insolation [kJ/cm²] of different aspect and slope classes during the period of ripeness in September and October (50° N).