Bulgarian Journal of Agricultural Science, 17 (No 1) 2011, 93-98
Agricultural Academy

GIS BASED LAND SUITABILITY ASSESSMENT FOR GERMAN CHAMOMILE PRODUCTION

A. GHASEMI PIRBALOUTI[1*], M. BAHRAMI[2], A. R. GOLPARVAR[3] and K. ABDOLLAHI[1]
[1] *Islamic Azad University, Shahrekord Branch, Researches Centre of Medicinal Plants and Ethno-Veterinary, Shahrekord, Iran*
[2] *Department of Agronomy, Islamic Azad University of Science & Research Branch of Ahwaz, Ahwaz, Iran*
[3] *Department of Agronomy and Plant Breeding, Islamic Azad University, Khorasgan Branch, Isfahan, Iran*

Abstract

GHASEMI PIRBALOUTI, A., M. BAHRAMI, A. Reza GOLPARVAR and K. ABDOLLAHI, 2011. GIS based land suitability assessment for German chamomile production. *Bulg. J. Agric. Sci.,* 17: 93-98

German chamomile (*Matricaria chamomilla* L.) is the most important medicinal herb and new crop. Chamomile crop has recently been exploited to boost cultivation area in Iran. The potential of land for agricultural use is determined by an evaluation of agro-ecological variables. Soil, climate and topographical environmental components are import agro-ecological variables. Evaluation of ecological variables is usually a first step in land use analysis. Geographic Information System (GIS) was used to identify suitable areas for chamomile production in north of Khuzestan province, Iran. Relevant environment-components such as soil chemical characteristics (pH, EC and organic matter), climate factors (temperature and precipitation) and topography (DEM) at different spatial and temporal resolutions were considered. The results of maps this study by ILWIS $_{\text{(version academic 3.0)}}$ identified that 0%, 1.5% (15868.35 ha), 32.7% (345930 ha) and 65.8% (696091.6 ha) of land have currently highly suitable (S_1), moderately suitable (S_2) and marginally suitable (S_3) and not suitable (N) for chamomile crop production in north of Khuzestan, respectively.

Key words: Ecological variables; GIS; German Chamomile; suitable area

Introduction

Natural products can be important sources for new pharmaceuticals. Vascular plants continue to play a role both as sources of current drugs and in drug discovery. In recent years there has been renewed interest in natural medicines that are obtained from plant parts or plant extracts. Medicinal and aromatic plants (MAP) take a very small cultivation area in comparison to other groups of cultivated plants. Cultivation has therefore been considered an alternative to wild collection, as this may help relieve the over-exploitation of natural populations of medicinal plants (Mander et al., 1996). The objective in commercial medicinal plant production is to produce high yields

e-mail: ghasemi955@yahoo.com

per hectare with high marker compound content. The ecological needs in production are the major aspect that influences the yield of all horticultural and agronomic crops.

German chamomile (*Matricaria chamomilla)* is a member of the Asteraceae (Aster family) and it's an annual herb and native to Iran (Reichinger, 1977), Western Asia and Europe that grows as a wild plant (Pourohit and Vyas, 2004). Chamomile is one of the most important medicinal plants in the world trade that has many applications in drug and sanitary industrials. Chamomile has medicinal attribute such as antiseptic and therapeutic use, anti-inflammatory (Pourohit and Vyas, 2004), antispasmodic (Pourohit and Vyas, 2004), and antimicrobial (Letchamo and Marquard, 1993). German chamomile is a new crop (alternative) has recently been exploited to boost cultivation areas in world and Iran.

The problem of selecting the correct land for the cultivation of a certain agriculture product is a long-standing and mainly empirical issue. Although many researchers, organizations, institutes and governments have tried to provide a framework for optimal agricultural land use, it is suspected that much agricultural land is used at below its optimal capability (Boonyanuphap et al., 2004). The increased need for herbal drugs production and the shortage of resources stimulate a need for sophisticated methods of land evaluation to aid decision makers in their role to both preserve highly suitable lands and satisfy producers' demand for increased profit (Ghasemi Pirbalouti et al., 2008). Land evaluation is a procedure that involves a lot of information which is distinguished by its geographic and multivariate character (FAO, 1996). The potential of land for agricultural use is determined by an evaluation of the climate, soil and topographical environmental components, and the understanding of local biophysical restraints (Ceballos-Silva and Lopez-Blanco, 2002). This evaluation is an essential step for sustainable cultivation of medicinal plants. It is necessary to assess the land suitability for medicinal herbs cultivation in the area by integrating various kinds of information with spatial analysis technique.

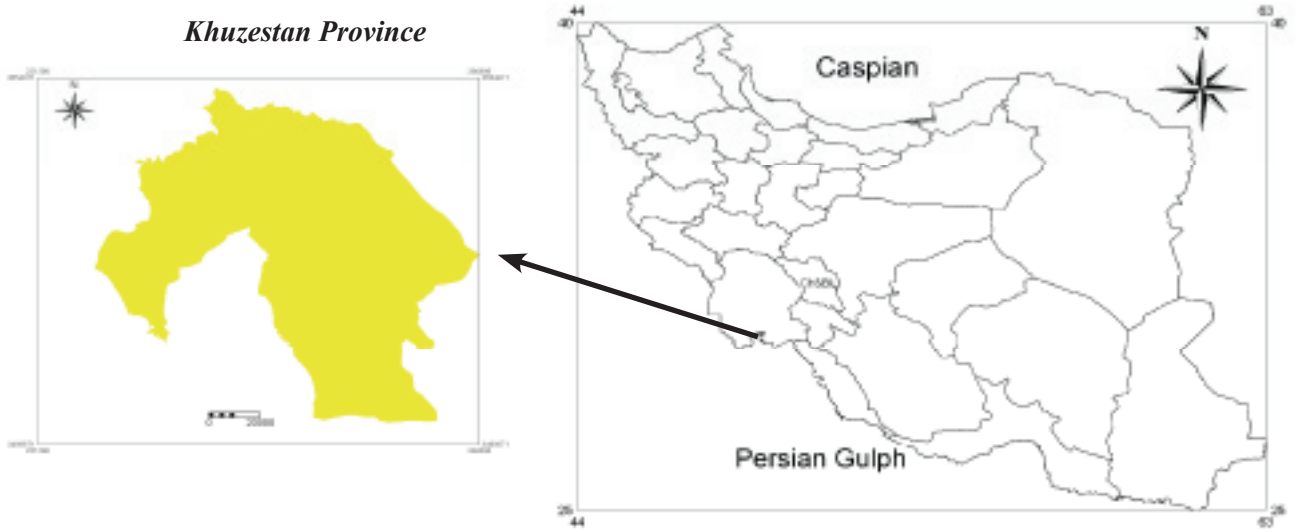
Geographic Information System is an organized collection of computer hardware, software, geographic data and personal designed to efficiently capture, store, update, manipulate, analysis and display all forms of geographically referenced information (ESRI, 1996). GIS has the ability to perform numerous tasks utilizing both spatial and attribute data. This powerful tool allows decision markets to simulate effects of management and policy alternatives within a geographic area prior to implementation. Also, GIS is a tool that can be used to predict alternative crop growth and yield (Ghasemi Pirbalouti et al., 2008).

GIS can be effectively applied to handle such kinds of work and to complete study objectives, these are (1) to construct the geographical databases of land suitability for German chamomile (*Matricaria cammomilla*) cultivation, (2) to assess land suitability for chamomile using Geographic Information System and (3) to select the possible lands for new chamomile cultivation in Khuzestan, Iran.

Materials and Methods

The study carries out in Khuzestan province, southwest Iran, which is one of the most important areas for crops production in Iran. The study area covers approximately 1057890 hectares of total area of Khuzestan province (Map 1). This area is located between latitude 31° 39′ N and 32° 58′ N and between longitude 48º 16′ W and 49º 52′ W. The elevations range between 0 and 3700 masl. The natural vegetation is rangeland and oak forest; most of the areas are used for agriculture. The chamomile crop was chosen in this investigation because has recently been exploited to boost cultivation areas in Iran.

Meteorological information was obtained from variation weather stations located within the study area and the surrounding zone. The number of years registered at the weather stations ranged from



Map 1. Location of the study site, north of Khuzestan Province, I.R. Iran

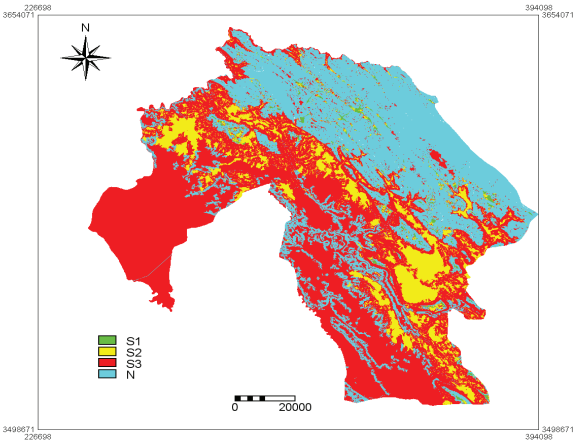
10-15. Average values for each variable per 10-day calendar period were calculated. The minimum and maximum temperature maps were adjusted by a thermal gradient. This regional thermal gradient was generated by a regression model that took into account the elevation and temperature of weather stations located in Khuzestan province, Iran. Chemical soil characteristics (pH, EC, and organic matter) were taken from a soil-sampling from 518 farms of agriculture lands of north of Khuzestan province. The slope and elevation information were obtained from the Digital Elevation Model (DEM) using two well-known GIS software packages ILWIS (version academic 3.0). The DEM used in the study has a spatial resolution of 3 arc-secs in geographical coordinates. This corresponds to a pixel size of approximately 80 m at the latitude of Khuzestan province. This array was geo-referenced using a metric UTM coordinate system and the geometric correction was carried out in the GIS ILWIS (ITC, 1998).

Geographic Information System (GIS) was used to build the geographic and ecological database for chamomile cultivation as well as for land suitability assessment and chamomile sustainable cultivation using multifactor spatial analysis. Using Global Positioning System (GPS)[1] during field in 2006-2007 collected the location of farms. Study on spatial distribution pattern in importance variables provide information about current environmental situation in geographic. All scored variables, which resorted in vector-based geo-database, were converted into the raster –based datasets with 100-meter grid cell size. The restricted area was overlaid with the classed current environmental suitability datasets using the multiple overlay operation to assess land suitability for chamomile cultivation.

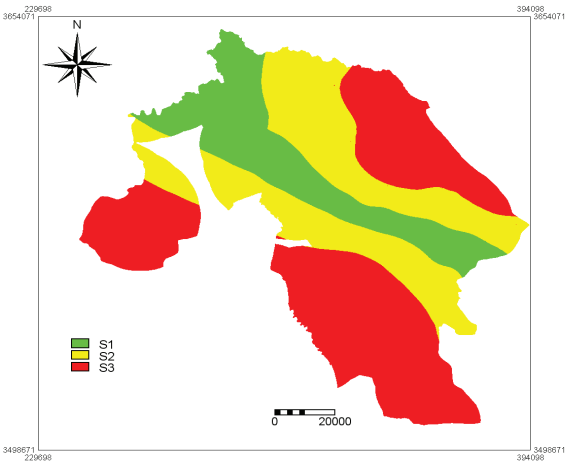
Results and Discussion

Climate, soil chemical characteristics and DEM data layers were prepared and suitability classes were determined, using modified FAO method, were matched against specific German chamomile requirements derived from agricultural experiments and literature review. In the first stage, suitability was assessed in terms of topography. Elevation alone did not affect land suitability, because this factor affected on climatic, soil and agronomic management variables (Ghaffari et al., 2000). The result of raster map of slope in study lands identified that 32.4 % (3429892.5 ha), 9.7% (1020480 ha), 5.1 % (540117.5 ha) and 52.8% (5383090

[1] - *Garmin Etrex Vista Model*



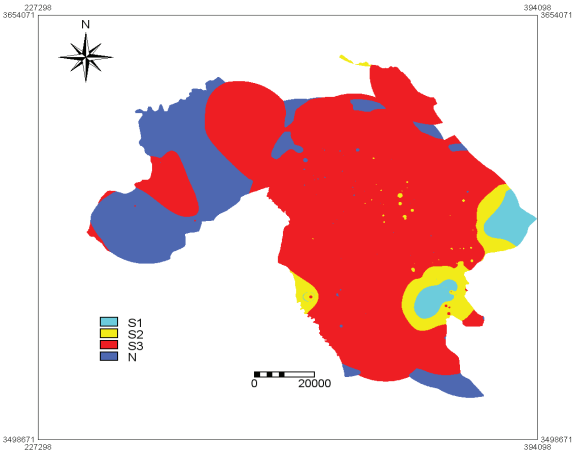
Map 2. Raster map of overlay topography by simple limitation approach



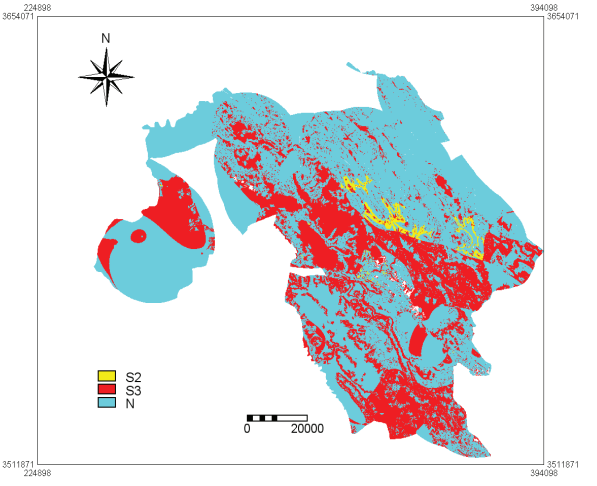
Map 3. Raster map of overlay climate variables by simple limitation approach

ha) of land have highly suitable (slope 0-2.5 %), moderately suitable (slope 2.5-5 %), marginally suitable (slope 5-7.5 %) and not suitable (slope > 7.5 %) for irrigated German chamomile production in north of Khuzestan Iran, respectively. Sys et al. (1991) believed that, on slopes than 20%, mechanization become impossible and for slope less than 20 percent there are still important variations in productivity according to variation in slope. Also, Bagli et al. (2003) reported that on slopes less than 5%, irrigation of crops become possible.

The result of raster map for elevation indicated that 16.3% (172716 ha), 29.5% (312638.8 ha), 46.9% (498000.3 ha) and 7.1 % (74537 ha) of study area have highly suitable (S_1), moderately suitable (S_2), marginally suitable (S_3) and not



Map 4. Raster map of overlay soil chemical characteristics by simple limitation approach



Map 5. Raster map of overlay climate, soil chemical characteristics and topography by SLA

suitable (N) for German chamomile cultivation, respectively.

The results of overlay raster maps for topography by simple limitation approach indicated that 0.9%, 11.5 %, 33.9% and 53.7% of lands have highly suitable (S_1), moderately suitable (S_2), marginally suitable (S_3) and not suitable (N) for German chamomile cultivation, respectively (Map 2).

The results of overlay maps for climate variables (maximum and minimum daily average temperature, monthly precipitation and number of freezing days) by simple limitation approach indicated that 13.5% (457731.3 ha), 39.8 % (391205.2 ha), 46.6 % (132969 ha) and 0 of lands have highly suitable (S_1), moderately suitable (S_2), marginally suitable (S_3) and not suitable (N) for German chamomile cultivation, under irrigation in study area, respectively (Map 3).

The results of overlay maps for soil chemical characteristics (OC%, Ec and pH) by simple limitation approach (SLA) indicated that 3.5 % (31497 ha), 5.8 % (52638.3 ha), 70.7 % (645065.5 ha) and 20.1% (182895.3 ha) of lands have highly suitable (S_1), moderately suitable (S_2), marginally suitable (S_3) and not suitable (N) for German chamomile cultivation, under irrigation in study area, respectively (Map 4).

In general, land suitability assessment by simple limitation approach for overlay maps (climate, soil chemical and topography characteristics) indicated that 0%, 1.5% (15868.35 ha), 32.7% (345930 ha) and 65.8% (696091.6 ha) of land have currently highly suitable (S_1), moderately suitable (S_2) and marginally suitable (S_3) and not suitable (N) for chamomile crop production in north of Khuzestan, respectively (Map 5).

Conclusions

This research confirmed that climate and topography environment-components proved to be useful in the identification of suitable areas for German chamomile production, within a GIS environment. This investigation is a climatologically evaluation that provides information at a regional level that could be used by farmers to select their crop pattern. As well, decision-making regarding adequate crop patterns could be based not only on the information provided by this approach, but also on other aspects such as: production supports, marketing, technological level, and economic evaluation, in addition to local customs, which are also highly important (Ceballos-Silva, and Lopez-Blanco, 2002). The main limiting factors are the geomorphology (slope and elevation) and climate (precipitation) and agronomic management (sowing date, irrigation and weed control) characteristics in study areas.

Acknowledgments

This work received support from the vice chancellor for research at the Islamic Azad University of Science & Research Branch of Ahwaz, Meteorological Organization of Iran and Jihad-Agriculture Organization of Khuzestan, Iran.

References

Bagli, S., J. M. Terres, J. Gallego, A. Annoni and J. Dallemand, 2003. Agro-pedo- Climatological Zoning of Italy. Definition of Homogeneous Pedo-Climatic Zones for Agriculture. Application to Maize, Durum Wheat, Soft Wheat, Spring Barley, Sugarbeet, Rapeseed, Sunflower, Soybean, Tomato. EUR 20550/EN.

Boonyanuphap, J., D. Wattanachaiyingcharoen and K. Sakurai, 2004. GIS-based land suitability assessment for Musa (ABB group) plantation. *Journal of Applied Horticulture*, **6**: 3-10.

Ceballos-Silva, A, and J. Lopez-Blanco, 2002. Evaluating biophysical variables to identify suitable areas for oat in Central Mexico: a multi-criteria and GIS approach. *Agriculture Ecosystem and Environment Journal*, **95**: 371-377.

Environmental Systems Research Institute (ESRI), 1996. Building applications with Map Objects.

Redlands, *Calif. Environmental Systems Research Institute Press.*

Food and Agriculture Organization of the United Nations (FAO), 1996. Agro-ecological Zoning Guidelines. FAO Soil Bulletin. N. 76. FAO. Rome.

Ghaffari, A. A, H. F. Cook and H. C. Lee, 2000. Integrating climate, soil and crop information: a land suitability study using GIS. *4 th International Conference on Integrating GIS and Environmental Modeling (GIS/EM4)*. Alberta, Canada, September 2-8.

Ghasemi Pirbalouti, A., G. H. Normohammadi, G. H. A. Kamali, A. Ayeneh Band, J. Porhemmat, K. H. Abdollahi and A. R. Golparvar, 2008. Integrating agro-climatological variables in order land suitability evaluation for rapeseed sustainable production by geographic information system (GIS) in Southwest Iran. *Crop Research*, **36**: 180-185.

ITC, 1998**.** ILWIS the integrated Land and water information system user's manual. International Institute for Aerospace Survey and Earth Sciences, Enschede, The Netherlands.

Letchamo, W and R. Marquard, 1993. The pattern of active substances accumulation in chamomile genotypes under different growing conditions and harvesting frequencies. *Acta Horticulture*, **331**: 357–364.

Mander, M., J. Mander and C. Breen, 1996. Promoting the cultivation of indigenous plants for markets: Experiences from KwaZulu-Natal, South Africa. Institute of Natural Resources Occ. Pap.167, p. 12. Institute of Natural Resources, Pietermaritzburg.

Pourohit, S. S and S. P. Vyas, 2004. Medicinal Plants Cultivation. *Agrobios Press*, India.

Reichinger, K. H., 1977. *Flora Iranica*, **22** (158) 82–88.

Sys, Ir. C., E. Van Ranst and J. Debaveye, 1991. Land evaluation. Part I. Principles in land evaluation and crop production calculation. International training center for post-graduate soil scientists, University Ghent.

Received January, 12, 2010; accepted for printing November, 23, 2010.