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Locating and Prioritizing of Agricultural Processing Industries (Apple, Grape, and pomegranate) in Markazi Province through Multi-Criteria Decision-Making Methods; ANP and GIS

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Abstract

One of the most efficient relationships between industry and agriculture is to construct Processing industries in villages. Spatial Planning due to uneven Geographical Distribution of Activities and services, can achieve even geographical distribution of activities, resolving overpopulation, filling voids, reduction in migration from village to city and in general grasping even distribution of human population on land. In this study, multi-criteria decision-making methods (ANP and GIS) are used to locate and prioritize processing industries in Markazi province. Criteria are valued and weighted by Network Analysis and through "Super Decisions" program. By determination of criteria weights maps is rendered in GIS and reported. Final map is categorized in 1-9 fashion in which 9 represents the most desirable location for processing industries environmentally and 1 represents the least in that manner.

Keywords: ANP, GIS, locating, multi-criteria decision-making, processing industries

Introduction

Iran is a country fit for agriculture and livestock which can produce agricultural products and process raw agricultural products, both can partially meet economical demands. Exporting raw material to neighbor

countries leads to improving in processing units in those countries. So, constructing processing industries in villages are so important in economical respect and for enhancing in industry and agriculture.

Spatial Planning due to uneven Geographical distribution of Activities and services, can achieve even geographical distribution of activities, resolving overpopulation, filling voids, reduction in migration from village to city and in general grasping even distribution of human population on land. Studying distribution and scattering of industries on Iran's geographical zone specially in village industries suggests that in most cases industries were constructed in an illogical and illegal locations and for most those industries are facing problems like water shortage, labor shortage, lack of suitable markets and environmental degradation. These problems can attribute to lack of attention to locating principles and laws, and choosing unsuitable methods for locating.

Markazi province with holding high position in production agricultural products as well as livestock products and moreover, possessing great location is suitable for developing processing industries. Therefore, decision-making for locating suitable industries is vital.

Annually, a considerable number of agricultural products are damaged due to lack of suitable markets availability, thus constructing small industries specially processing industries are a suitable solution for agricultural development. Considering importance of locating these industries in agricultural development and dependency of this decision to multiple variable, decision making should begin in determining variables and weighting them in a proper model.

Decrease in damaged agricultural products leads to increase in production without development in area under cultivation which decrease damaging environment. Moreover, production cost would be dropped dramatically and products quality would be enhanced. Eventually producers will gain more and nutrition condition will improve and modified.

Processing industries are depended to agricultural products and in production process every agricultural and livestock product is consider as raw material. Agricultural processing industries are one of the subsets of food industries which deals with processing vegetables and animal products. This processing includes deformation and preservation through physical and chemical changes, storing, grading, classification, and distribution (Sahebi, 1995).

Weber (1909) was first to study industries locating comprehensively and provides theory on this matter. In Weber's model, industries tend to choose locations in which shipping costs, labor costs and costs related to aggregation and scattering are minimum. Chandra (1992) considers important factors for locating industrial activities are shipping costs, labor, available economical activities, land, water, infrastructures, assets, raw material availabilities, energy, and investment sources. Tacher (2009), in his study about juice production and market concludes that in 2008, juice production net growth was 2 billion liters in UK. The Study was carried out in USA, New Zealand, Poland, Chile and UK which indicates growth in market during a 5-year period. Harin and Pernia (1986) studied effective factors in industrial locating in Philippines and conclude that major customers availability, Main road availability, reliable power system, telecommunication services, land, suitable buildings and space for extensions, skilled worker, raw material availability, reliable water supply systems, public transportation to industrial site, land and buildings rent availability, low cost land and suitable infrastructure for industries are effective factors. Darbi and mark (2012) determined optimized location for sugar factory with consideration of cellulose ethanol plants availability and in this study, plants were compared paying attention to their economical performance and shipping costs. Kishor by studying in Orisa state of India concludes that improving infrastructure of a region can enhance location advantages, including better locating industries which follows better performance. Kishor also evaluates factors like raw material, market, investment conditions, Demand, and financial and credit facilities influence industrial development (Kishor, 2004). Libersion et al. (2005), in "An evaluation of the Bangladesh agro-based industries and technology development" reviews agricultural products including poultry, fish, garden

products, beans, grains, and diary products. Plan purposes effectiveness and operational solutions were predicted and evaluated. Rezaii studied feasibility of locating processing and additional industries of animal products in Ilam province. Study's approach is mixture of quantitative and qualitive methods (Rezaii, 2007). Taherkhani (2007) used TOPSIS method to prioritize locating of processing agricultural industries in village areas. One variable was studied in this paper which is raw material availability. Nori and Tabatabii (2007) used Delphi method to prioritize processing and additional industries in agriculture in felavarjan district, Isfahan province. Ziari and Ashrafi (2008) used analytic hierarchy process for the most suitable location to construct juice industry in bonab district. Babajani et al. (2009) employed combined indexing and Geographical Information System (GIS) to locate processing industries of garden products in Kermanshah province. Firouzi Nezam Abadi and Javanmard (2013) studied effective factors on locating processing industries by means of factor analysis method and ANP in Markazi province pursuing detection and determination of effective factors on locating processing industries and providing an operating model to solve it.

In previous studies in association with processing industries multiple multi-criteria decision-making methods were employed such as: TOPSIS, hierarchical analysis, factor analysis, analytic network process and delphi method.

In this study analytic network process (ANP) was employed. Analytic network process (ANP) considers interdependencies between decision factors, criteria, sub-criteria, and choices. ANP method is developed form of AHP which is able to model regressions and feedbacks between effective factors and takes internal components into account for decision making therefore this method is superior to previous models.

Effective factors in processing industries locating was graded by "Super Decisions". This software was designed for hierarchical and network models analysis so that it could be employed for complex networks to obtain the best choice. In this software, after data entering and determining connections between factor and comparing them, weighted super matrix, unweighted super matrix, sensitivity analysis, compatibility rate are calculated. Results are illustrated as calculated maps through GIS.

Methods and Material

Valuation of factors and criteria is done employing multi-criteria decision-making. Selection of a unique choice is desired between multiple probable choices. ANP method were employed for weighting criteria. Satty (1995) provided a multi-criteria decision-making called analytic network process. For years, ANP method is used as a widespread and multi-functional method in complex decision-making. ANP emphasize on interdependence of superior components to inferior ones and interdependence of every existing factor. Correlation between results and real world with its complexities is key element of this method. Effective factors as questionnaire forms were provided to specialist for conjugate comparison. For Implementation of ANP, hierarchical phase was obtained, conjugate calculation, and weighted values was calculated and priorities and importance percent were determined by "super decisions". Eventually, via map superimposing and obtained criteria weights processing industries were graded and the most suitable location is determined. Data and statistical information were collected from ministry of agriculture, Agriculture Research Center, Bureau of Natural Resources of Markazi Province, and Statistical Center Website. Province Maps were purchased.

Results

In this Study criteria valuation was carried out by "Super Decisions" program. First step is to draw a pattern of all desired criteria which demonstrates goal connection kind, Criteria, sub-criteria, and decision choices (Figure1).

Effective factors in locating processing industries were divided into 4 groups of: environmental factors, supportive factors, Production factors, and infrastructure services. For each group questionnaire was drafted and specialists conjugate comparison was carried out. So that calculations and super matrix was prepared Figure 2. final weight of choices was determined Figure 3.

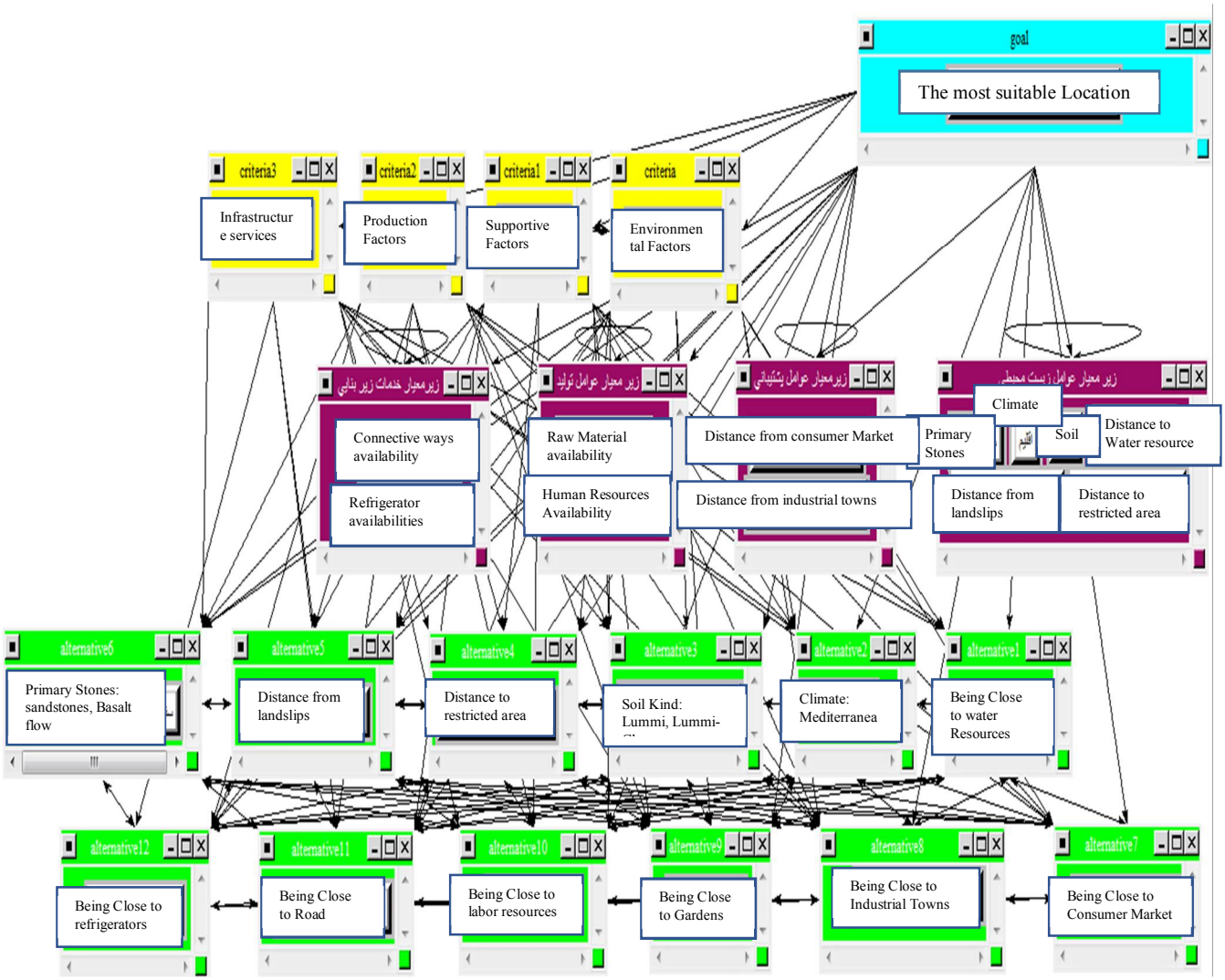

Figure1: connection goals, Criteria, and Choices pattern

Figure2: Weighting Super Matrix

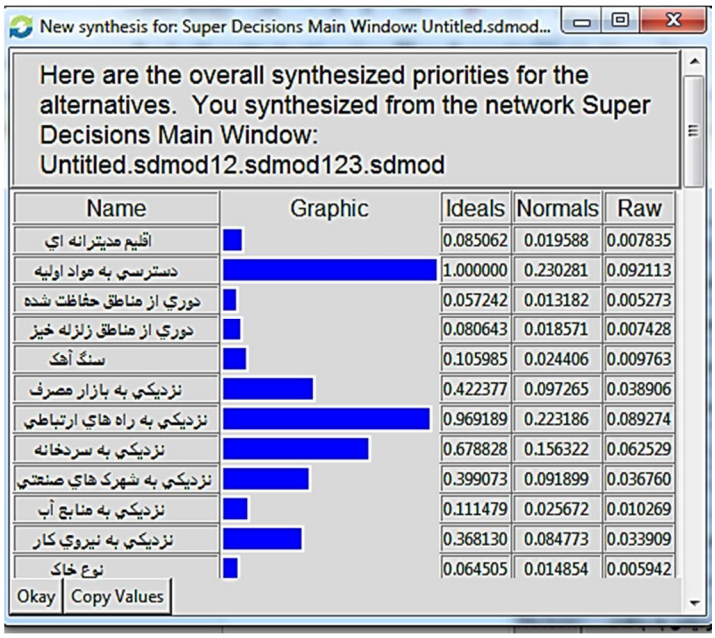

Figure3: Final Criteria Weights

In second step determining weights of every criteria, Criteria mixture through GIS is performed. In GIS on every fundamental map operation were to be made, in general every map was converted from vector to roaster. For determining overall weight of maps Reclass tool was employed. After reclassing, Final weight of map is entered and then derived map is being reclassed and considering zoned it is classified 1 to 9. Final map is being converted to vector 9Figure 4).

The most suitable location to construct Processing was illustrated with number 9. As it downgraded to number 1, ideal location is more out of access. Thus, areas with higher number are more desirable. These areas are closer to raw material, Roads, refrigerators, town, industrial areas, and markets which have higher rank in criteria and are further from restricted areas and landslides.

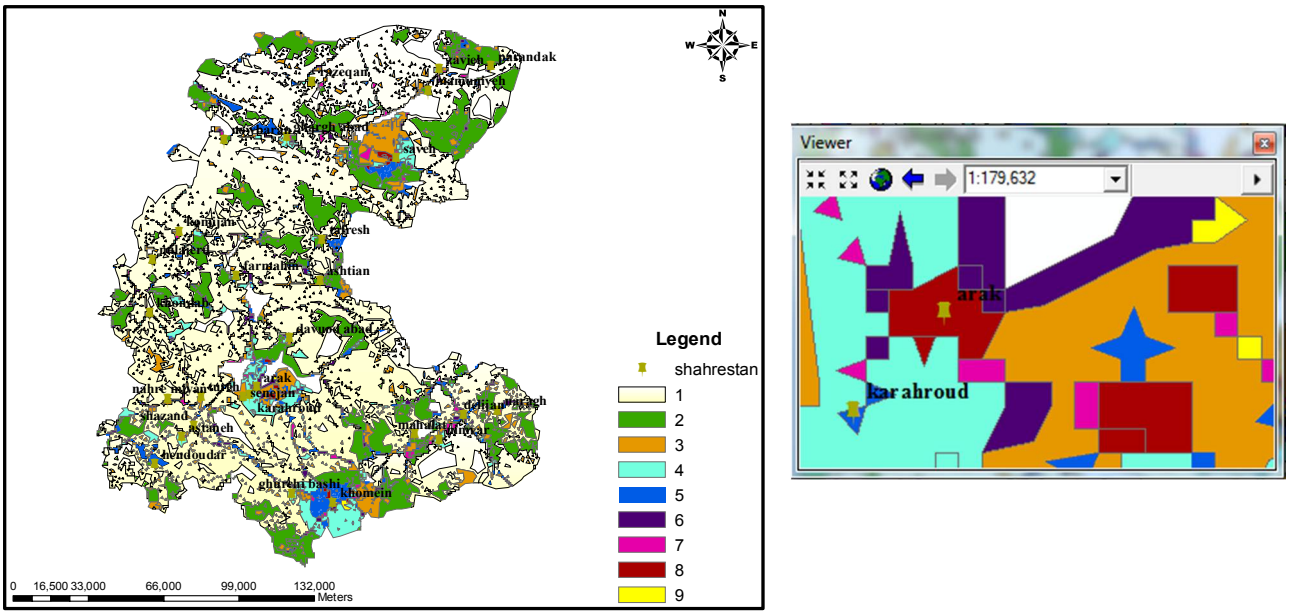

Figure 4: final map and vector

Discussion and conclusion

This study was performed to locate suitable area for agricultural processing industries in Markazi province. Processing industries -as economical link for agriculture and industrial economics- are vital for improving quality of agricultural products, exporting, boosting producer's benefit, and eliminating middlemen. Processing and supplementary industries of agricultural sector are significant because of elevating added value, export development, reduction in waste, and decrease in risk factors with considering food industry is second significant industry after heavy industry in world. Marketing as means of continuous availability in target countries and improving quality of products is vital as in this case agricultural productions are 3 to 5 times greater than region needs. Markazi province is involved in production of more than 15 leading in country including: Apple, Raisin, Peach, Almond, Walnut, Flowers, Decorative plants, pomegranate…which can be optimized by developments in processing units which leads to development of province. Besides, Primary industries are available in province and construction of Processing industries can lead to economical jump.

Through literature review, criteria for locating Processing industries were recognized and important ones were selected. Criteria were prioritized and weighted employing ANP and "super decision" in order form more effective to less: being close to raw material 23, being close to connective ways 22, being close to refrigerator 16, being close to consumer market 10, being close to town and industrial areas 9, being close to human resource 9, being close water resources 3, Mediterranean climate 2, primary stones 2, suitable soil 2, distance from restricted areas 1 and distance from landslide 1. With determining criteria, weight mixture and maps were performed in GIS and map was provided as the main result. Final map was classified from 9 to 1 in which 9 indicates the best locating area for processing industries environmentally and number 1 indicates the worst condition.

Recommendations:

1) Constructing Processing industries related to garden products (Grape, Apple, and pomegranate) to reduce waste and damages and shipping costs and efficiency enhancement.
2) Improving connective ways of Arak, Khomein, and Saveh to facilitate product shipment and food.
3) Budget assignment and special facilitations for agricultural sector investors, right investment with proper management in agriculture sector and related industries in relevance to food and increase in export.
4) Refrigerator, store, silo construction with sufficient facilities in Markazi Province districts in order to preserve agricultural and garden products and food.
5) Deployment of mechanical agricultural equipment to harvest agricultural and garden products in order to reduce agricultural waste and increase processing rate.
6) Increase in deploying skilled human resource in agricultural sector and industries in order to harvest using new and efficient methods.

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