

# **BENEFITS, OPPORTUNITIES, COSTS AND RISKS (BOCR) MODELS AND CONTINGENCY VALUATION FOR ESTIMATING THE PROVISION OF PUBLIC GOODS IN BULGARIAN AGRICULTURE: SOUTH CENTRAL PLANNING REGION**

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## **Abstract**

*This paper builds a multi-criterial model in the special template of the Benefits, Opportunities, Costs and Risks (BOCR) using Analytic Network Processes (ANP) technique having as alternatives three main public goods in Bulgarian agriculture: South Central Planning Region. The specific construction of the model allows it to further articulate on specific Bulgarian policy considerations derived from the European Union's Common Agricultural Policy (CAP) and to design policy recommendations so that one specific public good –if wanted-is stimulated. Sensitivity analysis concluding the paper provides an insight over the derived relative importance of public goods on particular directives in the CAP. Also, all the methodology and particular surveys administrated in Bulgaria could be easily replicated in context countries and determine specific and effective policies mix to enforce, for example, significant improvements in the Public Goods' (PG) provision in agriculture across EU's countries as well as to determine more precise monetary values associated with these improves.*

**Key words:** public goods, multi-criteria analysis, analytic network processes, contingency valuation

## **Introduction**

Public good is an item whose consumption is not decided by the individual consumer, but by the society as a whole. A public good (or service) may be consumed without reducing the amount available for others and cannot be withheld from those who do not pay for it. The OECD, in its analysis of public goods in farming and forestry suggests using various ways to ensure adequate provision of public goods according to the social norms and the level of private provision. The public financing is just one of them. Other authors have found similarity between PGs and private goods. They include both tangible goods and less tangible services demanded by society. A previous large survey conducted in the South Central Planning Region of Bulgaria prior to this study identified the most important three public goods delivered within regional agricultural activities, on both supply and demand side. These three goods are Food Safety, Water Quality and Scenery and Recreation. Further on, a large-scale survey was conducted with the participation of the stakeholders in

the South Central Planning Region and results were individually inputted in the direct mode in the model. Weights of importance for the alternatives were weighted and in the end what was delivered from the experts was averaged with what was delivered from the stakeholders. Contingency valuation was also included in the survey designated for the stakeholders and this allowed to determine monetary value for Food Safety in the context of the three public goods considered. The specific construction of the model allows this model to articulate it on further up specific Bulgarian policy considerations derived from the EU's CAP and to design policy recommendations so that one specific public good –if wanted-is stimulated. Results show that the monetary value associated to the improvement with one unit of the existent Food Safety conditions is of approximately 22 BGN, sensible equal to the one associated with the other two public goods considered, only if in the policies designed to promote these public goods emphasize twice more Benefits of Food Safety then the costs associated with it (comparing 0.526, the weight of importance for Benefits with 0.2785, the weight of importance for Costs) while Risks in achieving one unit in improving the Food Safety should almost be left aside when presented to the public. Depending on the participants to the survey, the same estimations are intended to be performed with the suppliers of public goods and results to be compared. Regarding the contingency valuation, this model emphasizes the dependence on the various importance granted to the generic benefits, opportunities, costs and risk.

## 1. Literature review

The integrative approach of both tangible and intangible effects of any productive activity in agriculture regarding the public goods provision of the Analytic Hierarchy and Network Processes (AHP,ANP) methodology as a multi-criteria decision making tool is acknowledged in several European international projects as well as significant research. Several such projects, where AHP/ANP models were constructed and combined with other techniques in order to assess various aspects in the creation and valuation of the public goods in agriculture are mentioned below:

- PROVIDing smart DELivery of public goods by EU agriculture and forestry (01 September 2015-31 August, Topic: ISIB-01-2014,Call: H2020-ISIB-2014-2, Funding Scheme: Research and Innovation Action (RIA));
- CLAIM – Supporting the role of the Common agricultural policy in LANDscape valorisation: Improving the knowledge base of the contribution of landscape Management to the rural economy (2012-01-01 to 2014-12-31, Topic: KBBE.2011.1.4-04 – The CAP and landscape management, Call: FP7-KBBE-2011-5, Funding Scheme: CP-FP – Small or medium-scale focused research project);
- AWARE – How to achieve sustainable water ecosystems management connecting research, people and policy makers in Europe (2009-06-01 to 2011-11-30, Topic: ENV.2008.4.2.3.2. – Enhancing connectivity between research and policy-making in sustainable development, Call: FP7-ENV-2008-1, Funding Scheme: CSA-CA – Coordination (or networking) actions);
- SECOA - SOLUTIONS for ENVIRONMENTAL CONTRASTS in COASTAL AREAS (2009-12-01 to 2013-11-30, Topic: ENV.2009.2.1.5.1 - Sustainable development of coastal cities, Call: FP7-ENV-2009-1,Funding Scheme: CP-IP-SICA – Large-scale integrating project for specific cooperation actions dedicated to international cooperation partner countries (SICA);

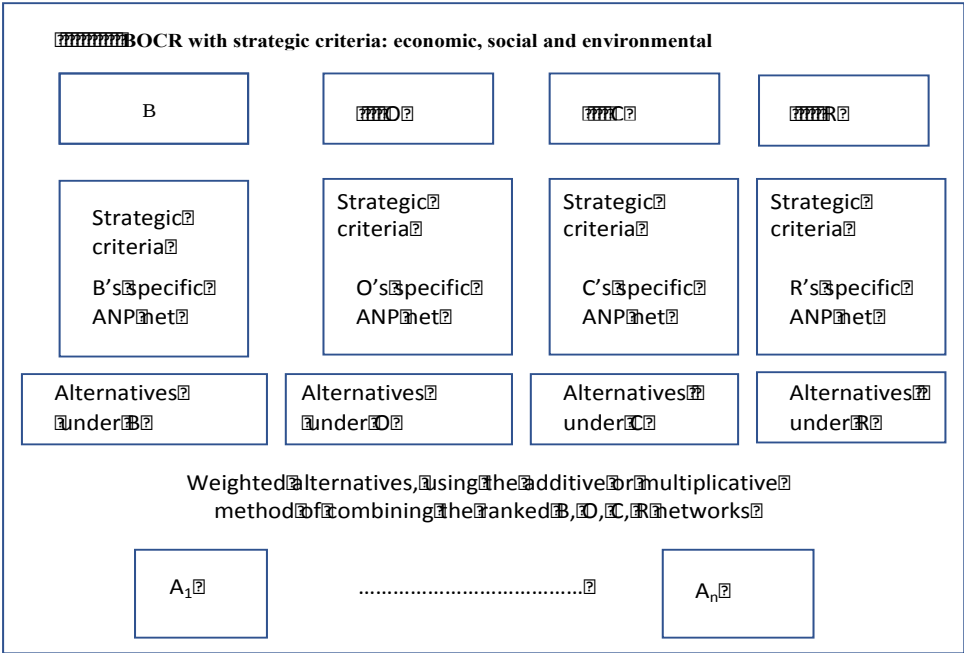
- TDSEXPOSURE (Total Diet Study Exposure) (2012-02-01 to 2016-01-31, Topic: KBBE.2011.2.4-02 – Pan-European Total Diet Study, Call: FP7-KBBE-2011-5, Funding Scheme: CP-IP – Large-scale integrating project)

Acknowledging the need of political decision in the provision of public goods (PG's) in the agriculture, (Villanueva, A.J., Gómez-Limón, J.A., Arriaza, M., & Nekhay O. 2014) establish a complex classification of factors and their interdependencies as basis of the proper management of farming systems and public goods as externalities associated. Following on the previous research, the agricultural farms' multifunctionality under various agricultural policies is analyzed following an extended survey with 400 farmers according to the AHP methodology in (Torres, C.C., Parra-López, C., Hinojosa-Rodríguez, A., & Sayadi, S. 2014). The conclusion that the economic performance is compatible with social objectives including employment in agriculture is compatible with the similar objectives enforced by the European Common Agricultural Policy (CAP). Building on the multifunctionality dimension of the agricultural sector (Kallas, Z., Gómez-Limón, J.A., & Barreiro-hurle, J. 2007) show how contingent valuation can augment the AHP technique for determining the monetary value associated with the demand side for the provision of several PG's specific to individual farmers. The correspondence between the agricultural policy and stakeholders' preferences, without a clear distinction between the demand and supply side is studied in the context of the AHP methodology and PG's provision in (Miškolci, S. 2013). The role of the developing countries in setting current problems in agricultural research is confirmed by the conclusions of this paper. The AHP technique embedded in a multi-criteria resource allocation tool proved to be an efficient method in coping with a large set of complex factors in a forestry management unit, as in (Šegotić K., & Posavec S. 2007). Adding value to the literature regarding the renewable natural resources as forestry is, Šegotić K., & Posavec S. (2007) illustrate the scientific foundations of determining forest value –as a significant public good.

## **2. Benefits, Opportunities, Costs and Risks (BOCR) Models using Analytic Network processes (ANP) in the context of Multi-Criterial Analysis**

Analytic Network Processes (ANP) theory as introduced by Thomas Saaty (see Saaty, 2009) belong to the multi-criterial decision making (MCDM) topic and it is grounded on the mathematical theory of stochastic matrices, eigen values and vectors, graphs and networks as well as on the behavioural economics and decision making. The building blocks in modelling certain decision problem in this context are clusters, nodes and connections. Pairwise comparisons of the nodes are done with respect to certain control criterion and the most linguistic to numerical scale is Saaty's 1-9. In assessing the importance of several alternatives, benefits and costs are difficult to be expressed in monetary terms, especially when tangible aspects must be compared with intangible ones. One of the most complex models within the theory of Analytic Network processes (ANP) is the network with BOCR. A BOCR model will have four separate hierarchies: Benefits hierarchy (B), and similar Opportunities hierarchy (O), Costs hierarchy (C) and Risk hierarchy (R). The importance of criteria in its correspondent hierarchy is pairwise estimated and this process produces relative criteria weights. Synthesis of the alternative priorities in a weighted sum produces conditional alternative priorities for each hierarchy. Using an extra control hierarchy represented by strategic criteria like economic, social and environmental the alternatives under each of the previous four networks are weighted into final ones. A detailed description of the estimation of a BOCR with both advantages and

shortcomings is described in a schematic representation of the BOCR ANP model is shown in the Figure 1, below.



**Figure 1. The structure of a BOCR-ANP model**

Source: The Authors

The model developed in this paper has the above particular form described in the context of the Figure 1. The strategic criteria are *Social*, *Economic* and *Environment*. Clusters considering categories of influence on the demand side of the previously mentioned three public goods were constructed after a careful literature review. Most influential papers are listed in the references. The decision to consider the three public goods in the alternatives as being the Water Quality, Food Safety and Scenery and Recreation was taken after a large survey on the prevalent public goods in Bulgarian agriculture was conducted. Also, every node considered, as well as the connections in between nodes resulted from the large-scale survey with both experts and representatives of the demand and supply side involved in the delivery and consumption of the public goods presented in (Nikolov D. Mihnea A., Boevsky I., Borisov P., Radev T. (2017)). It is shown in previously cited paper how the required data for estimation of public goods (PGs) were collected by conducting focus groups, during which were discussed in depth study subjects, thanks to the benefits of developing group dynamics and effect. During the discussions by spontaneously thorough discussion of the predetermined range of issues were formulated clear categories and definitions, which helped to better explain and understand quantitative studies of phenomena. The discussions were led by a moderator who put matters to discuss, monitor the equal participation of persons focuses on interesting new guidelines spontaneously expressed by the participants. In leading the discussion moderator uses the following projective techniques: Techniques Association techniques and complementarity.

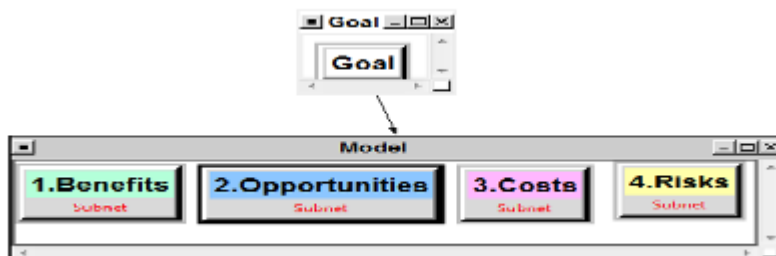
The discussions attended by 14 people – farmers, representatives of agricultural associations, local public authorities and consultants. The participants were divided into two groups of 7 persons. Each group received natural-geographic map of the area and a list of ten potential PGs. Each participant was asked to determine distribution of public goods in the region using 3 colour sticky notes (red = available; white = neutral; blue = no). As a result, it was found that the most important public goods/bads in the region are: Water Quality, Food Safety and Scenery and Recreation. Nodes in every previous cluster were distributed according to their influence split on the three strategic criteria and separately, benefits, opportunities, costs and risks for each of the three alternatives. Their distribution is shown in the Table 1 below.

**Table 1. Node distribution in the BOCR model**

| <i>Elements</i> |             | <i>Water quality</i>                 | <i>Food safety</i> | <i>Scenery and recreation</i>         |
|-----------------|-------------|--------------------------------------|--------------------|---------------------------------------|
| Benefits        | Social      | RURAL POPULATION                     | COOPERATIVES       | POTENTIAL TOURIST                     |
|                 | Economic    | RURAL POPULATION IN THE HOTSPOT AREA | FOOD CLUSTERS      | RURAL POPULATION IN THE HOTSPOT AREA  |
|                 | Environment | LOCAL AUTHORITIES                    | COOPERATIVES       | POTENTIAL TOURIST                     |
| Opportunities   | Social      | SUBSIDIES                            | SUBSIDIES          | ECO-ROAD                              |
|                 | Economic    | POTENTIAL TOURIST                    | CROP ROTATION      | POTENTIAL TOURIST                     |
|                 | Environment | Water                                | ECO-STANDARDS      | HIGH NATURAL VALUE LAND               |
| Costs           | Social      | SUBSIDIES                            | SUBSIDIES          | SUBSIDIES                             |
|                 | Economic    | WATER                                | ECO-STANDARDS      | LAND                                  |
|                 | Environment | IRIGATION COSTS                      | ECO-STANDARDS      | SOIL DERGADATION                      |
| Risk            | Social      | SKILLED WORKFORCE                    | DISEASES AND PESTS | AIR-QUALITY                           |
|                 | Economic    | FLOODING                             | SKILLED WORKFORCE  | SOIL EROSION                          |
|                 | Environment | BIO-DIVERSITY                        | DISEASES AND PESTS | ROAD (INFRASTRUCTURE AND MAINTENANCE) |

Source: Authors

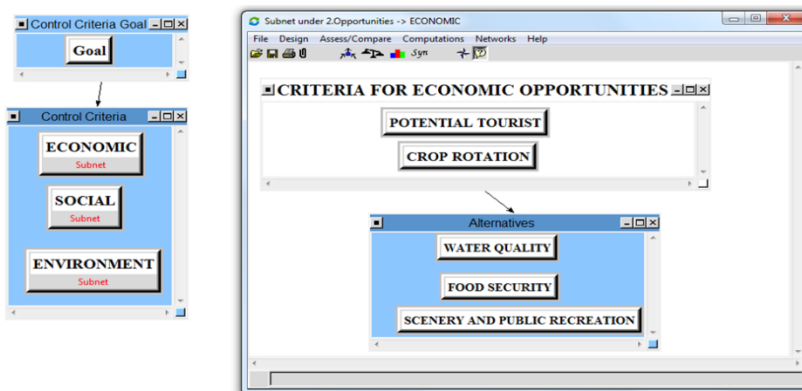
The above constructed BOCR model was implemented in the freely available Super Decisions Software where there is a special BOCR template. The appearance of the general structure as it schematic presented in Figure 1 is shown in Figure 2 below.



**Figure 2. BOCR template in the Super Decisions software**

Source: The Authors

In Figure 3 below it is shown how the row containing the node distribution of Opportunities, economic with respect to the alternatives-having only two nodes: Potential Tourist and Crop Rotation is implemented within the BOCR template in the Super Decision Software.



**Figure 3. BOCR criteria for economic opportunities**

Source: The Authors

### 3. Conclusions

This paper builds a multi-criterial model in the special template of the BOCR using ANP technique having as alternatives the previously three main public goods. Nodes were considered from the previous studies, as mentioned, while their grouping in clusters, and connections according to the influence were established based on a focus group with experts in agriculture from South Central Planning Region of Bulgaria. Strategic criteria in this BOCR model were Economic, Social and Environmental and every aspect regarding Benefits, Opportunities, Costs and Risk in demanding these public goods was weighted against these three strategic criteria, as well as all the alternatives and the intermediary

nodes. This focus group validated the model and provided estimates of it using the pairwise comparison and the 1-9 Saaty numerical scale according to the usual ANP methodology.

The model was estimated using the Super Decisions Software and individual opinions were aggregated using of the geometrical mean, according to the specific group decision methodology specific to the ANP technique. Further on, a large-scale survey was conducted with the participation of the stakeholders in the South Central Planning Region and results were individually inputted in the direct mode in the model. Weights of importance for the alternatives were weighted and in the end what was delivered from the experts was averaged with what was delivered from the stakeholders. Contingency valuation was also included in the survey designated for the stakeholders and this allowed to determine monetary value for Food Safety in the context of the three public goods considered.

The specific construction of the model allows this model to articulate it on further up specific Bulgarian policy considerations derived from the EU's CAP and to design policy recommendations so that one specific public good –if wanted-is stimulated. More precisely, the results show that under an equal importance granted to the main four aspects, Benefits, Opportunities, Costs and Risks, the weight of importance of the Food Safety is negative, meaning underestimated with 40%. This means that the Costs and Risks are underestimated with respect to Food Safety in Bulgaria and therefore the public is not willing to pay when the demand for this public good was estimated by the stakeholders. If Benefits in the improving with one unit on the Food safety are twice emphasized with respect to the correspondent Costs, then the associated importance of the three public goods become sensible equal and the monetary value associated with one unit of improvement in the Food Safety is about 22 BGN. This show how, using sensitivity analysis within this model a convenient policy mix could be designed so that, in particular, one out of these three public goods will be favoured, in accordance with the national and Eu's CAP. Also, all the methodology and particular surveys administrated in Bulgaria could be easily replicated in context countries and determine specific and effective policies mix to enforce, for example, significant improvements in the Food Safety across EU's countries as well as to determine more precise monetary values associated with these improves.

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