Jul 1st, 12:00 AM

An Intelligent Decision Support System for Environmental Impact Assessment of Industrial/ Agricultural Projects

Shady Aly

Ivan Vrana

An Intelligent Decision Support System for Environmental Impact Assessment of Industrial/Agricultural Projects

Shady Aly[a], Ivan Vrana[b]
[a]*Assistant Professor, Helwan University - Faculty of Engineering, Cairo, Egypt*
[b]*Professor, Czech University of Life Sciences, Prague, Czech Republic*
vrana@pef.czu.cz, shadyref@yahoo.com

Abstract

An Environmental Impact Assessment (EIA) is an assessment of the likely positive and/or negative influences an industrial project may have on the human health or environment. The assessment can have several dimensions like Air pollution impact, Noise/vibration impact, Water pollution impact, Ecological impact (Geological hazard impact & Endangered species impact), etc. Actually, there is a wide prevalence of situations of environmental impact and human risk assessment. This paper attempts to present a non-conventional solution for treating the complex EIA decision problem. It is typically a complex ill-structured decision making problem that involves: huge quantities of data to manipulate, low quality of data (uncertainty, measurement errors, missing data), different spatial and temporal scales (from seconds to years, from local to global), dynamic and stochastic behavior, and being at the crossroad among many disciplines/domains, and so many qualitative or subjective factors. In addition, the mentioned environmental dimensions often include non-homogenous subsets of input factors or variables. Consequently, in these situations, the decision-making problem becomes so complicated when we need to assess the overall environmental impact of a newly proposed or existing industrial project, specifically, we need to decide whether to adopt or proceed with the project. Such a binary, YES/NO, decision problem requires assessing the influences of all non-homogeneous inputs factors within the given relevant environmental dimensions or views. One way to obtain a reliable solution to such a complex, critical decision problem is to rely on the knowledge, heuristics, and experience of different expertise's corresponding to each environmental dimension. In this paper, we propose a modular intelligent environmental decision support system that makes use of fuzzy logics and appropriate human expertise's in rigorously assessing the impacts of the proposed or existing project on the surrounding environment or human health. The proposed system includes multiple fuzzy expert systems (FESs), each of which contains the homogenous and aggregated knowledge and expertise's relevant to a one relevant environmental dimension. An objective numerical scale is established to assess the decision outputs of each individual system, expressing the degree of bias to "Positive" or "Negative" environmental impacts. Consequently, for a project to be adopted or accepted it must attain a combined or aggregate value in favor of the "Positive" impact outcome; otherwise the project will be rejected.

Integrating multiple intelligent decision support systems is considered particularly useful in obtaining, high quality, more comprehensible, and reliable decision solution. However, the reasons for independency can be related to ease of maintainability, analyzability, context flexibility, decision-making modularity, sensitivity of aggregate knowledge, decision consistency, etc. The problem of integrating multiple FESs involves combining their final individual crisp outputs. Every FES participates in judging the

problem based on a predefined match between problem context and the required specific expertise's. In this research, a consensus-based heuristic will be used as the basic mechanism to combine the outputs of multiple FESs. The heuristic exploits the consensus-relevant information among FESs decision outputs, and is guided by two sets of consensus measures or indicators. The first set is a group of six similarity-based indicators. The second includes voting's and voting's weights derived measures. The arithmetic mean (AM) combining rule is utilized as additional decision guide. The weights are to be computed utilizing the widely used decision making tool, the Analytical Hierarchy Process (AHP). The proposed consensus based heuristic is particularly adequate for the nature of the binary decision problem in which decisiveness is much more required than a compromise. The presented results can also improve decision-making process in many other disciplines, as e.g. environmental risk assessment, new product launching decision, food quality tracking, etc.

Keywords: Fuzzy Expert Systems, Outputs combination/aggregation, Analytical Hierarchy Process, Multiple Parallel Processing, Binary Group Decision-Making, Consensus Analysis.

References

Aly, S., & Vrana, I., "Integrating Multiple Fuzzy Expert System under Varying Requirements"; Proceedings of the 5th International Congress, on Information Technology in Agriculture, Food and Environment, Adana, Turkey, Oct., 2005.

Vrana I. & Aly S.: Multiple parallel fuzzy expert systems utilizing a hierarchical fuzzy model. Agricultural Economics, 53, 2007 (2): PP. 89-93.

Bryson, N., "Group Decision-Making and the Analytic Hierarchy Process: Exploring the Consensus- Relevant Information Content", Computers Ops Res., Vol. 23, No 1, PP. 27-35, 1996.

Ngwenyama, O. K., Bryson, N., Mobolurin, A. "Supporting facilitation in group support systems: Techniques for Analyzing Consensus Relevant Data"; Decision Support System, 16, PP. 155-168, 1996.

Saaty, Thomas L. (1980): The Analytical Hierarchy Process; New York: McGraw-Hill. Giorgio Guariso, Hannes Werthner, Environmental Decision Support Systems, John Wiley & Sons, 1989, ISBN:0-470-21431-7.

Ulises Cortès, Miquel Sànchez i Marrè, Luigi Ceccaroni, Ignasi R-Roda, Manel Poch, Artificial Intelligence and Environmental Decision Support Systems, Applied Intelligence, 13 (1), 2000.

A.E. Rizzoli and W.Y. Young, "Delivering environmental decision support systems: Software tools and techniques," Environmental Modeling and Software, vol. 12, no. 23, pp. 237--249, 1997)

Andrea Emilio Rizzoli, "Environmental decision modeling": http://www.idsia.ch/~andrea/edss/edss.html