Hierarchical Systems Analysis in Karst Terrains: Part B. Analysis of Environmental Impacts of Aggregate Mining

William H. Langer and Kenneth E. Kolm

The abstract that follows was presented at Portoroz, Slovenja, at the North Atlantic Treaty Organization Advanced Study Workshop on Sustainable Mineral Resource Management in Karst Areas, held September 26 – October 1, 2000. The illustrations that accompanied the presentation are provided in this Open-File Report in Power Point® Presentation (.ppt) and Power Point® Show (.pps) formats.

Limestone and dolomite are used in construction as crushed stone, dimension stone, and cement, and also are used for various agricultural, industrial, and environmental purposes. Of the non-fuel mineral resources, the carbonates are third in terms of volume, and fourth in terms of value, in worldwide production. Limestone and dolomite have specific physical and chemical properties that make them the preferable source of stone for many construction uses, and the only acceptable source of stone for many agricultural, metallurgical, industrial, and environmental uses.

Limestone resources cannot be obtained from the landscape without causing some environmental impacts. Quarrying involves development in an environment that may only be partially defined in a physical, chemical, biological, or anthropogenic sense, and there is always a degree of uncertainty about the type and extent of adverse impacts that could arise. Furthermore, there is very little information about the impacts, primarily hydrologic, of extraction of construction materials in karst terrains. Therefore, the ability to predict impacts of mining in karst terrain is problematic. Many of the discussions of environmental impacts of mining aggregate in karst areas are speculative, are based on geologic intuition and inference, or are assumed to be similar to those for other mining operations in karst terrains, such as those for coal, phosphate, and metallic minerals.

Part A of this paper (Part A read me) describes how a hierarchical systems analysis (HSA) can be used to characterize natural systems in karst terrains. After system characterization is complete, HSA focuses on identifying potential environmental impacts that may result under a variety of mining scenarios and mitigation techniques. The potential environmental impacts are dependent on two factors; 1) the mining and processing methods and engineering controls, and 2) the natural and anthropogenic systems. HSA is iterative, and involves changing and reevaluating the parameters of these two factors.

Once potential impacts have been identified, HSA is used to identify initiating events, to evaluate the consequences of the various impacts on specific systems, to determine which impacts are acceptable, and to explore mitigation techniques. One way to assess environmental impacts is to characterize their nature. The nature of an impact can be expresses in terms of: 1) the range of the impact, 2) the timing of the impact, 3) the duration of the impact, 4) the magnitude of the impact, 5) the ability to predict the impact, and 6) the ability to control the impact.

The HSA continues with an analysis of the likelihood that an initiating event or combination of initiating events will trigger environmental impacts, and evaluations of methods to decrease that likelihood.