2005 年美国大学生数学建模竞赛 MCM、ICM 试题

2005 MCM A: Flood Planning

Lake Murray in central South Carolina is formed by a large earthen dam, which was completed in 1930 for power production. Model the flooding downstream in the event there is a catastrophic earthquake that breaches the dam.

Two particular questions:

Rawls Creek is a year-round stream that flows into the Saluda River a short distance downriver from the dam. How much flooding will occur in Rawls Creek from a dam failure, and how far back will it extend?

Could the flood be so massive downstream that water would reach up to the S.C. State Capitol Building, which is on a hill overlooking the Congaree River?

2005 MCM B: Tollbooths

Heavily-traveled toll roads such as the Garden State Parkway, Interstate 95, and so forth, are multi-lane divided highways that are interrupted at intervals by toll plazas. Because collecting tolls is usually unpopular, it is desirable to minimize motorist annoyance by limiting the amount of traffic disruption caused by the toll plazas. Commonly, a much larger number of tollbooths is provided than the number of travel lanes entering the toll plaza. Upon entering the toll plaza, the flow of vehicles fans out to the larger number of tollbooths, and when leaving the toll plaza, the flow of vehicles is required to squeeze back down to a number of travel lanes equal to the number of travel lanes before the toll plaza. Consequently, when traffic is heavy, congestion increases upon departure from the toll plaza. When traffic is very heavy, congestion also builds at the entry to the toll plaza because of the time required for each vehicle to pay the toll.

Make a model to help you determine the optimal number of tollbooths to deploy in a barrier-toll plaza. Explicitly consider the scenario where there is exactly one tollbooth per incoming travel lane. Under what conditions is this more or less effective than the current practice? Note that the definition of “optimal” is up to you to determine.

2005 ICM: Nonrenewable Resources

Select a vital nonrenewable or exhaustible resource (water, mineral, energy, food, etc.) for which your team can find appropriate world-wide historic data on its endowment, discovery, annual consumption, and price.

The modeling tasks are:

1. Using the endowment, discoveries, and consumption data, model the depletion or degradation of the commodity over a long horizon using resource modeling principles.

2. Adjust the model to account for future economic, demographic, political and environmental factors. Be sure to reveal the details of your model, provide visualizations of the model's output, and explain limitations of the model.

3. Create a fair, practical "harvesting/management" policy that may include economic incentives or disincentives, which sustain the usage over a long period of time while avoiding severe disruption of consumption, degradation or rapid exhaustion of the resource.

4. Develop a "security" policy that protects the resource against theft, misuse, disruption, and unnecessary degradation or destruction of the resource. Other issues that may need to be addressed are political and security management alternatives associated with these policies.

5. Develop policies to control any short- or long-term "environmental effects" of the harvesting. Be sure to include issues such as pollutants, increased susceptibility to natural disasters, waste handling and storage, and other factors you deem appropriate.

6. Compare this resource with any other alternatives for its purpose. What new science or technologies could be developed to mitigate the use and potential exhaustion of this resource? Develop a research policy to advance these new areas.