Water quality management and control of pollution in lakes

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INTRODUCTION

Jaunay lake is a water reservoir of 3.700.000 m^3 located at the North of France (see Figure 1). It has historically been exploited for recreational activities and human consumption. The company Vendee Eau own a water treatment plant located at a distance of 20 km from the lake, which is in charge of the water intake, its purification and its distribution to neighboring populations. This water intake results in a reduction in the lake volume, which becomes alarming in dry seasons when this volume decreases to half of its capacity.

Figure 1. Jaunay lake

PROBLEM STATEMENT

In order to preserve the lake volume to a desired value, the company Vendee Eau proposes to refill the lake with reused water (which contains pollutant) coming from the water treatment plant. The objective of the problem is to find the optimal location of the removal and refilling pipes so that the pollutant does not enter to the areas of the lake devoted to recreational activities (see Figure 2). To his aim, we consider an Advection-Diffusion-Reaction PDE model to simulate the evolution of the pollutant concentration and taking into account: the geometry if the lake, the position of the pipes and their effect on the water, the wind and water currents. This model will be implemented by considering the FEM software Comsol Multiphysics. Then, we enunciate an optimization problem to find the optimal position of the pipes and solve this problem by using the Matlab optimization toolbox called GLOBAL OPTIMIZATION PLATFORM (see: http://www.mat.ucm.es/~ivorra/soft.htm).
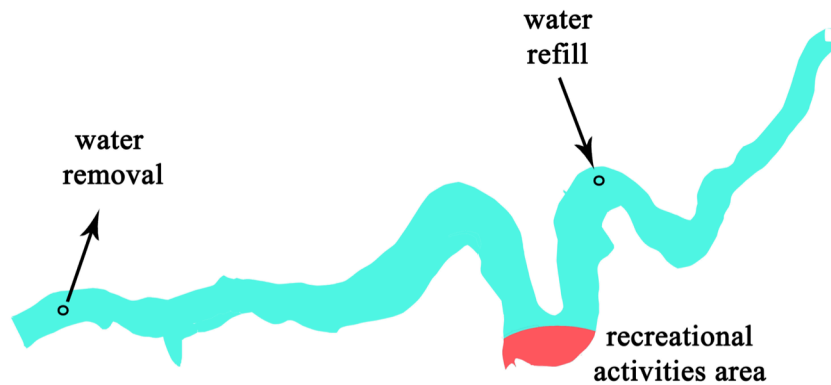
Used software:

Figure 2. Problem statement

WORKING PLAN

The company Vendee Eau will provide to the participants real data regarding the geometry and volume of the lake, as well as a physical description of the pipes used through the process. Data concerning the wind effects and water currents will be also supplied, as well as the characteristics of the considered pollutant.

The steps to solve this problem could be:

1. **MATHEMATICAL MODELING:**
    Develop an Advection-Diffusion-Reaction model that describes the evolution of the pollutant concentration in the lake through the refilling process.

2. **NUMERICAL SIMULATION:**
    Develop a COMSOL Multiphysics model to compute a numerical solution of the mathematical model.

3. **OPTIMIZATION:**
    State an optimization problem aiming to find the best location of the removal / refill pumps. Solve it by using the Matlab optimization toolbox GLOBAL OPTIMIZATION PLATFORM.

4. **RESULTS:**
    Present the obtained results and conclusions.

Used software: