Preface

This book is designed to highlight some of the applications of location analysis in a variety of different fields. In some sense, it is a companion piece of the "Foundations of Location Analysis" volume that was published in 2011. While the latter book focused on the problems that can be solved, this book describes scenarios, in which location techniques have been used to solve actual problems.

It is well known that the techniques that are usually described in books and taught in many location courses—medians, centers, covering problems—are but prototypes that may be applied to real situations when suitably modified. In addition, many location problems comprise multiple objectives, which makes tools from multicriteria decision making an attractive choice. As was stated elsewhere, the fact that location problems are typically found on the strategic level, means that more often than not, simple single-objective optimization models may very well be a good starting point, but have to be supplemented by other tools that allow the inclusion of more sophisticated features, such as nonlinear choice rules and multiple objectives.

This book features spotlights on some important applications of location models and the different tools used in the decision-making process. There are three main classes of applications: applications by businesses, those that deal with public services, and applications that deal with law enforcement and first responders. Overall, it is noticeable that the public sector appears to be the main user of location models.

The first application in the private sector is described by Başar et al. The authors describe the location of bank branches in Istanbul, Turkey. The tool is a mixed-integer programming problem, whose objective is to maximize the net profit, based on the expected transaction volume at the branches as well as branch opening and closing penalties. One of the main issues here is a description of the banking behavior of individual and commercial users.

In the second chapter, Bhadury et al. discuss the potential location of a logistics park (a.k.a. freight village) in the southeastern part of North Carolina. The authors delineate a four-step procedure that incorporates the main phases of the location process: choice of the general region, identification of suitable sites within the chosen region, assessment of the sites that were identified in the previous step, and a

comparison of the sites. In the end, the situation had changed, and the logistics park was not built and a new process started. While disappointing, this is actually not uncommon: the case of the sewage treatment plant in Halifax, Canada, was, at least in that respect, similar.

In the third chapter, Gunn focuses on sustainable forest management. His main objective is the maximization of discounted profit. Again, the tool are mixed-integer optimization formulations. Important features include a concentration of the entire supply chain that comprises the forest, sawmills, pulpmills, and different products delivered to different customers. The constructions of roads to bring equipment to the parcels that are to be harvested is an important cost factor. Also important are neighborhood restrictions that ensure that the planners avoid denuding large swaths of land, which would foster erosion.

Chapter 4 by Arnolds and Nickel looks at layout problems in a hospital. It is well known that layout problems are much more difficult than location problems, as the former have to respect the shape of the facilities (e.g., rooms), whereas location problem essentially locate points in some space. The objective in this piece is to locate wards, walk-in clinics, and operating rooms so as to minimize travel distances and times. It is well-known that quadratic assignment problems, one of the cornerstones of layout problems, are already among the most difficult problems in integer programming. Any additional model features that make the formulations more realistic will further increase the degree of difficulty, so that heuristics have to be applied.

The first chapter dealing with public services is Chap. 5. Here, Church et al. deal with the design of habitats for wildlife in California under special consideration of the spotted owl. The tool of choice is a mixed-integer programming formulation of an anti-covering model. In general, the problem of designing a habitat is a difficult one, in part due to the different requirements of individual species: for instance, while mountain lions will thrive in large, contiguous areas, bald eagles will prefer a large number of small protected zones. If preserves for multiple species are to be designed, suitable compromises will have to be found.

Chapter 6 deal with the control of forest fires. Church et al. set up a multiobjective mixed-integer optimization model that includes fuel removal, the minimization of damage in the transition region, known as wildland-urban interface, the minimization of the variation in year-to-year workload of the crews, and the maximization of adjacency in some period and subsequent periods. The main concern is scheduling, and the authors set up a decision support system for that purpose.

Chapter 7 by Geetla et al. discusses the location of intelligent sensors along highways to enable emergency vehicles to respond in a timely fashion. The authors devise an explicit-implicit model, which is succeeded by an optimization that includes single and double coverage. It is noteworthy that the model maximizes coverage from nodes as well as coverage from paths for an area in a part of Buffalo, New York. A variety of sensitivity analyses establishes the robustness of the system.

In Chap. 8, Verter and Zhang describe the problem of locating breast cancer screening centers in Montreal, Quebec, Canada. The authors formulate a mixed-integer programming problem, whose objective is the maximization of the level

of participation in the program. Again, proximity and patient behavior are main features of the model.

Chapter 9 by Yezer and Gillula is rooted in economic theory. The paper performs an economic analysis for the locations of post offices. Among other concerns, included in the model are revenue, the number of windows, where service is offered, and the size of the facility. The objective is the maximization of net revenue per unit area of the facility. The authors' model allows the analysis of an existing retail network and permits decisions regarding the closures of some of the facilities.

In Chap. 10, Giesen et al. investigate the location of schools in a region of Brazil. The objective function minimizes the sum of transportation, operating, and penalty costs. Complicating features include the existence of different types of schools (public and charger schools), which operate under different rules (children must attend the school to which they are assigned by a central authority, or the child's parents have the choice), and there may be a choice between multigrade schools and single-grade schools. Communities, politicians, unions, and others have views that will have to be included for a successful implementation. A significant increase in the efficiency is possible when the system is adopted. One of the key recommendations for a successful implementation includes a smooth transition from the present solution to the optimized solution.

The third part of this book deals with applications of enforcement and first responders. Chapter 11 by Murray discusses the well-known problem of locating fire stations. The objective function for the problem in a city in California minimizes the sum of fixed and operating costs, while constraints ensure that a certain percentage of the demand is actually satisfied. The author's model is a generalization of the well-known maximum capture problem. After the recommendations were made to the authorities, the city in question merged with another population agglomeration, which, in conjunction with a general economic downturn, resulted in the fact that the system was not implemented. The lessons of the process, though, remain for future users.

In Chap. 12, Gentili and Mirchandani describe a model for the location of sensors for travel time information. These sensors can be used to detect changes in traffic patterns to avoid congestion as well as plan future traffic networks. The application maximizes the distance that can be monitored by the sensors. The model is applied in an area of Texas. Tradeoff curves are determined for the location of additional sensors.

In Chap. 13, Bucarey et al. consider the problem of police districting. Their model is a largely extended p-median formulation that locates centers of districts, so as to minimize a linear convex combination of three objective functions, *viz.*, the sum of center-customer distances, a penalty for odd shapes of the district, and prevention demand. Based on the complexity of this mixed integer programming problem, the authors design a location—allocation heuristic to solve the problem. The model is applied to Chile, resulting in major benefits as compared to the present solution.

In Chap. 14, Marianov analyzes the location of jails in Chile. A mixed-integer optimization problem is formulated, which minimizes the costs of opening new

facilities, the costs of expanding existing facilities, a penalty cost for inmates' transportation, and the last term is another penalty cost of overpopulation in the jail. The author outlines some of the major difficulties with this subject, particularly changes in demographics, changes in the law, and major trends, such as the increase in drug-related offenses.

Chapter 15 by Pelot et al. deals with the location of Coast Guard vessels off the Canadian Atlantic Coast, in order to be able to efficiently respond to incidents, whose severity is measured in different categories. The model also uses different workload capacities, and the different versions are variations on max cover problems.

In the last chapter of the book, Bell surveys military applications of location analysis throughout different periods of recent history. The type of models used in the military spans a wide range from weapons positioning, the selection of training sites, hospital locations, locations for search and rescue aircraft, the location of spare aircraft engines, the closure of military bases, and many others.

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