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THE UTILIZATION OF GIS IN GERONTOLOGY: —POTENTIAL APPLICATIONS AND EASE OF GEOGRAPHIC INFORMATION CREATION—

Hiroshi Ueda*

Abstract

Population aging is a phenomenon occurring not only in Japan but also worldwide. Along with the increasing number and percentage of elderly citizens in the population has brought heightened attention from a variety of areas such as public health, biology, psychology, sociology, marketing, social welfare and other services, and of course in gerontology. It is assumed that much interest in aging and the elderly has been continuously expressed to some extent along with the use of digital maps among researchers, academics, and the elderly.

Geographic information systems (GIS) have been successfully developing digital maps in recent decades, improving the processing speed of computers, and making available user-friendly, less expensive GIS software. It is expected that digital maps will be utilized in a variety of areas and will be, with sufficient opportunities, developed further in the area of aging.

This paper introduces some basic characteristics of GIS maps and their effectiveness as a visual tool and explores some examples of GIS map use and potential applications with a special attention given to gerontologists and elderly users. It is highly recommended that special attention be paid to visualization and the preparative steps to produce GIS maps for effective presentation and common use among map users including those who are not familiar with digital maps. Some physio-psychological changes among the elderly shall be considered in the map-making process for their map use. It is anticipated that GIS maps will be improved and made more user-friendly while gaining more support from a wide range of users—including the elderly—in the future.

Key words: elderly, demography, geographic information system, digital maps

In recent years, usage of geographic information in Japan has progressed from traditional print media to a digital media. During this time, digital map education, research, and general usage

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* Graduate School of Human Sciences, Osaka University, 1-2, Yamadaoka, Suita, Osaka 565-0871, Japan

have been remarkable, in conjunction with the development of affordable, user-friendly software with computer-based processing power. This paper will explore the synergistic effects of these developments by leveraging GIS in gerontology; we also discuss future GIS application issues in aging societies.

1. Introduction

Population aging is a global phenomenon. In Japan, there has been marked population aging due to a rapid rise in both the absolute elderly population numbers, and the proportion of the elderly due to declining birth rates and longer life expectancy after World War II. In October 2010, the population of elderly aged 65 or older reached approximately 29.58 million (12.64 million men, and 16.93 million women). This age demographic made up 23.1% of the entire population (Cabinet Office, 2011). In the future, we expect the percentage of elderly population to rise along with the absolute number of the elderly (Cabinet Office, 2011).

Although gerontology (which is the interdisciplinary study focused on aging, the elderly, and aging societies) is still relatively new and not well known in Japan, it is a field of study and research likely to gain attention in the future. There are many studies and surveys being conducted from a variety of perspectives and approaches on the lifestyle of the elderly and its relationship with society, not only in the field of gerontology, but in other academic fields as well. Therefore, the approach of utilizing maps to provide information complements these studies, and may have the hidden potential to provide independent services.

2. GIS and Its Characteristics

GIS is an acronym for Geographic Information System, defined as “technology that makes it possible to identify geographic location, comprehensively manage and process data possessing information on locations (spatial data), display visually, and perform advanced analysis and rapid judgments” (Geospatial Information Authority of Japan, 2011). The digitalization of geographic information over approximately the last half century has revolutionized the usage of traditional print maps. From around the mid-twentieth century on, map editing and processing is easier and faster due to the remarkable development of computer processing power, the development and usage of GIS software, and the availability of specific, accurate digital geographic information. Over the past few years, users from a broad range of fields have adopted GIS, making tremendous developments. This goes beyond simple map creation; its usage is found in various research and educational fields, extending to national land planning, land management, asset management, urban planning, transportation policies, environmental planning, disaster prevention, hazard maps, facility planning for water and sewage, electric and gas, business marketing, and location and route search services.

Using computers to create geographic information began with the development of a geographic information system to promote work efficiency in an agricultural land rehabilitation plan in Canada in the 1960s. After that, further development of systems from Harvard University and the U.S. Bureau of the Census transitioned into development in corporations. During this process, using computers to create maps from workstation GIS became possible (Coppock & Rhind, 1991; Murayama, 2008; Nabeshima & Ishikawa, 2006; Yano, 1999).

In Japan, practical applications of GIS in local regions began in the 1980s through the preparation of digitizing geographic information by the Geographical Survey Institute in the 1970s, and the development of urban information system for regional public entities. At the time, the systems were not popularized as much as anticipated because of their high cost, however, the 1995 Great Kobe Earthquake raised appreciation for the use of GIS, and the preparation/consolidation of GIS' digital information was underway (Murakoshi & Wakabayashi, 2008; Nabeshima & Ishikawa, 2006; Yano, 1999). "Earthquake Route Home Maps," which help people return home by foot after an earthquake or other disaster, are practical maps that post information about restrooms, hospitals, rest areas, regional shelters, and drinking fountains. These maps can be accessed not only through paper media, but also as digital information through mobile devices. In addition, following the 2002 introduction of the World Geodetic System, the August 2007 Basic Act on the Advancement of Utilizing Geospatial Information was enforced. Its aim was comprehensive, systematic promotion of policies related to the promotion of geospatial information utilization, and expansion of the potential linkage between geographic information systems and satellite positioning (Ministry of Land, Infrastructure, and Transportation, 2007).

We use two types of data formats in GIS: raster and vector. Their usage depends on the method by which the graphic is stored, and on diverse types of information. We generally refer to raster data as image data, such as digital camera photographs and satellite images. When expanded, these images contain a fine, graph paper-like mesh (also called grids), consisting of pixels comprised of patterns or coloration according to various characteristics. Raster images formats are stored as "tif", "jpg", or "bmp". The mesh of raster data holds location information and has a structure that possesses numerous attribute data. Conversely, vector data represents graphic outlines and two-dimensional coordinates using a combination of x-y coordinate values and length. In other words, it is a method of representing an image as a configuration of lines (vectors) displaying curved lines and surface contours. Through the coordinate connections, we can divide the image into points, lines, and polygons. We can use points to notate a building's position, lines to notate rivers and roads, and polygons to notate government boundaries and building perimeters. For vector data, attribute tables for each set of data are added (Machida, 2004; Shibayama, 2009; and Yano, 1999).

In GIS, we can use computers to create maps by overlapping layers that contain a variety of information. It is also possible to create simple, customized maps through the selection of

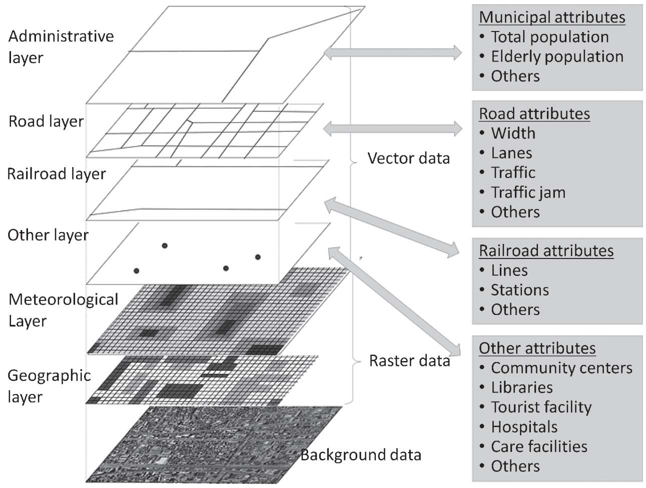

FIGURE 1.
Map representation models and layer composition, along with attributes

these layers. In these layers, it is possible to refer to superimposed aerial photographs and illustrations. Vector data is suited for displaying point and line information representing location coordinates; raster data is primarily used to represent the distribution of a subject over a plane surface (Figure 1). Shapefile format (shp), which includes coordinate information and image attributes, features, and numerical values, is often used to store vector data.

3. GIS System Configuration: Methods for providing and using information

The GIS configuration is generally divided into three types: a stand-alone system, a client-server system, and a WebGIS system (Figure 2). In the past, the stand-alone system of installing software on a single computer, conducting data analysis, and map generation was common. There was no environment where a large number of people could share map information. The era of delivering map information as electronic data to numerous networked computers came with the simplification of network environment maintenance. These networked computers comprise a client-server system. By sharing data on a network server, system users can reference and use data from their personal computers. However, given a network configuration, each GIS user needs to install software. Some problems remain, such as maintenance and complex system updates.

WebGIS has spread rapidly in the last several years (also called Internet GIS or Open Source GIS). Users can interactively use GIS functions and data stored on the server for map creation through network remote control. Compared to a stand-alone system, the data integrity of WebGIS is far superior (Nakaya, 2004). WebGIS has two types of methods: server processing and client processing. In server processing, the server performs information search and map creation based

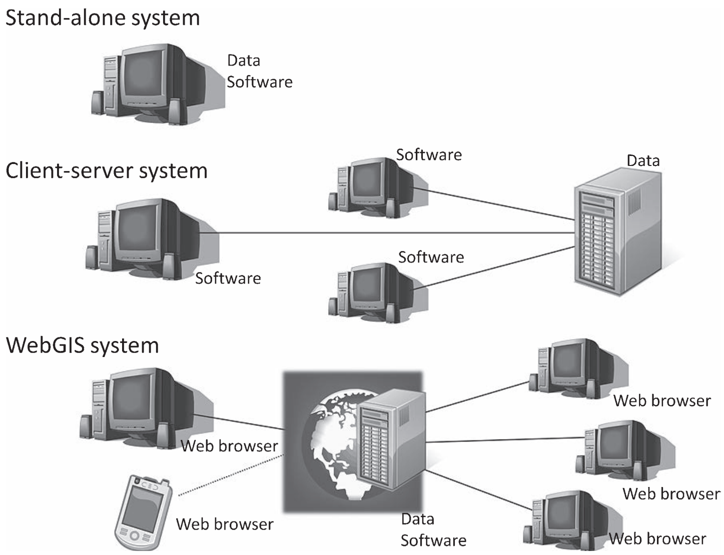

FIGURE 2.
GIS system configurations (with variations)

on a map creation request from the client. The request returns an image to the client and as such, the client does not directly process data. There is no need for clients to install GIS software if they have a suitable environment to view the map information. Although they receive rapid results, it is often difficult to obtain effective, detailed map information aligned with their various needs. Recent considerable improvements have reduced the burden of obtaining map information for users/clients. In client processing, users/clients use data and simple GIS software provided from the server to perform map-creation processing on their own computers.

Car navigation systems utilize GIS. They receive radio waves from over four satellites on machines equipped with Global Positioning System (GPS) to display maps. These systems are equipped with various service functions capable of displaying the search destination location on a digital map based on current location, address, and telephone number. In addition, they can plan a number of routes to a destination, provide traffic congestion information, show the estimated arrival time with estimated fees (or tolls), provide guidance to the destination, and display information for nearby services such as gas stations, restaurants, parking lots, and restrooms. Recent enhancements allow them to accept keywords from voice input and display any facilities matching the keyword.

4. Visualization

Visualization is the ability to display information that normally cannot be "seen" directly through images, graphs, maps, and tables. In GIS, various methods represent vector-type points, lines, and planes. To represent a point, simple marks and symbols such as "○", "△", "※" are used, differentiated by color and size. Lines can be distinguished by line types, such as solid, dashed, and wavy lines, or by line color and thickness. Planes can be differentiated by fill color and pattern, or by outline. As a result, the representation of information can use an object's size, color, brightness, hue, and saturation to distinguish information. Maps that show gradations of shades of a single hue and multiple systems of color are called choropleth maps (Figure 3). To accommodate for particular subjects, we use proportional symbol maps (which use symbols proportionally sized to an index value on administrative districts drawn on blank maps). In addition, we use chart maps using circle graphs and bar graphs (Brewer, 2005; Krygier and Wood, 2005; Shiode, 2008) (Figure 4).

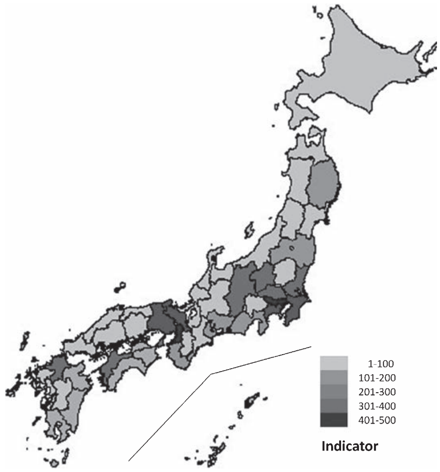

FIGURE 3.
Choropleth map example

When creating a detailed map, if there is a large difference in vicinity's index values, we can make adjustments by leveling the map using an empirical Bayes method, however, this is unsuitable when it is necessary to show the exact region specifics. There is also a map style called a cartogram that distorts maps based on statistical data to display regional features.

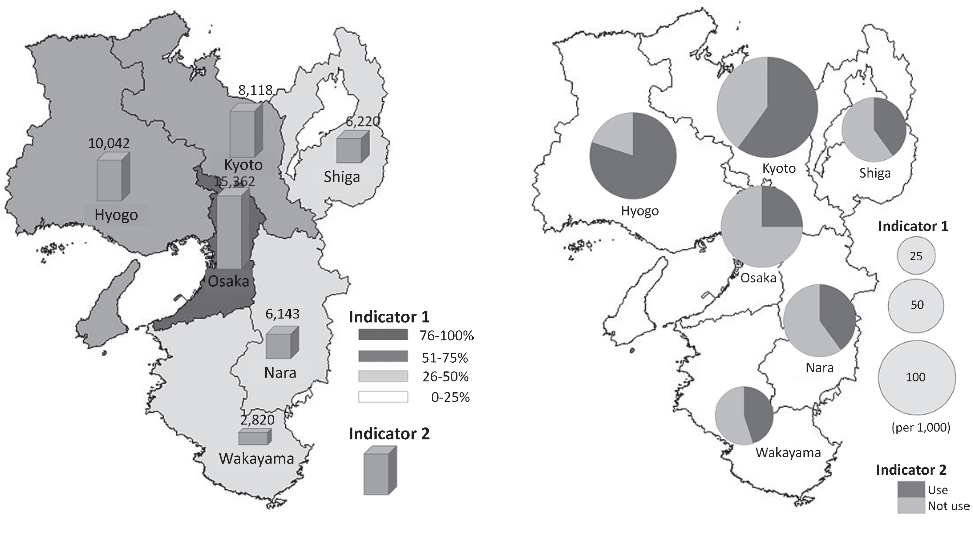

FIGURE 4.
Chart map examples

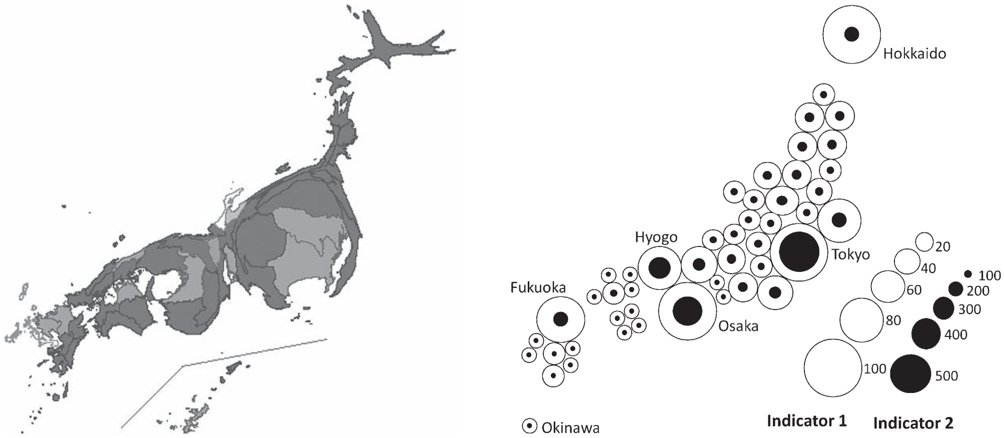

FIGURE 5.
Cartogram examples

Cartogram types include distance cartograms, which represent statistical data by distance, and area cartograms that represent data by area. Depending on whether regional boundaries and adjacent portions are considered, we classify area as either contiguous cartograms, or non-contiguous cartograms. For non-contiguous cartograms, each part of the map may be enlarged and reduced, and may be represented by an arrangement of circles (Nakaya, 2004, 2008, 2010). In any case, since cartograms distort the original shape of the map, users must know the map's original shape, or it needs to be visible in comparison to the original map (Figure 5).

With video visualization, we can show the changes in index time series with the number or distribution of points on a map, and changes in their movement and color. In addition, we can provide new information to users by adding symbols, graphs, and pop-up windows.

5. Basic Plan for GIS Installation

When we use GIS in the area of gerontology, just as its usage in other fields, it would be convenient if we can clearly define the numerous processes for completion of map information in advance, enabling us to investigate the requirements of the GIS software and the functions of the equipment.

5.1. Clarification of the Objective of GIS Usage

First, it is necessary to clarify the objective of GIS usage. Why is it necessary to create and obtain map information? What benefits do users obtain from this? Depending on the situation, the map information itself may not necessarily be the main objective; it may serve a supporting role as a visual for the results and understanding of the original objectives.

5.2. Clarification of GIS Users

Are the GIS users not the elderly but rather people working in academia and research related to aging societies? Will the users of map information provide services to the elderly based on this? Alternatively, will the elderly be the ones directly using GIS to obtain map information? Based on user clarification, a need will arise to change the size of the map, the lettering, and the representation methods.

5.3. Specifying Necessary Information

In order to obtain the desired map information, what sort of index data is necessary? For example, if statistical data on the elderly population and population aging rate is required, where does that data originate? How can you obtain facilities information when providing information about specific services for the elderly? For these purposes, it is first necessary to investigate collection methods and identify data that will become material for GIS map creation.

5.4. Clarification of the Types of Systems that Utilize GIS

As stated earlier, GIS systems are divided into three types: stand-alone systems, client-server systems, and WebGIS systems. Deciding which of these to use depends on who the map creators and users will be, whether or not multiple GIS users will process data jointly, and whether it will be necessary to digitally share the resulting map information.

5.5. Installing Software

Once the necessary system configuration has been determined, we select the software. In a stand-alone system, as users will essentially create map information alone, they choose appropriate software and install it on personal computers. The software can be either free or expensive, depending on GIS knowledge and proficiency. In a client-server system, it is necessary to install the same GIS software as the shared users. In a WebGIS system with a server processing method, it is highly possible that a viewing software already installed on a personal computer is sufficient. Installation of additional software other than GIS may be required depending on whether data obtained from the server needs to be processed.

5.6. Investigating Data Structure

During map creation, we perform an investigation of how we will use the obtained data. What are the minimum required layers? What data is used to manage the graphic information in the layers? How is the layer configuration constructed? What sort of information should be maintained as attribute information? What types of processing methods are necessary for producing user-friendly images? It is necessary to always consider data on terrain, rivers, roads, railways, and administrative boundaries, or accept these as required information when publishing maps. Recently, the use of background scenery images such as terrain maps, aerial photographs, and satellite images (e.g., Google Maps), have become useful.

5.7. Investigating Data Processing and Analysis

Once the data structure is settled, full-fledged data processing begins. Although we consider the type of system being used, the processing required for map creation differs depending on whether process execution is completed by the user, or by the remote server. If the user performs the initial map-creation operations, it is necessary to obtain the underlying blank map and address-matching data used for layer creation. Address matching in GIS, also called geocoding, is the assigning of coordinate points, such as latitude and longitude, to location and place-name information. The Center for Spatial Information Science at the University of Tokyo performs free processing and necessary data analysis related to geocoding.

5.8. Data Processing and Map Creation

When a user is actively involved in data processing and map creation using GIS software, they stack multiple layers and perform overlay analysis/processing to create one map associated with the attributes and shapes of each layer. They also perform buffer analysis to generate a specified area. Map creation is completed based on the data structure (*5.6*) examined above. By following these steps, it is possible to create accurate and effective map information.

6. Examples of GIS Usage in Gerontology

Usage of GIS in gerontology is divided broadly into the creation of maps using elderly-related data obtained through surveys and research, and situations in which the elderly are the GIS users. The elderly are not necessarily the users of the former, though these users include service providers for the elderly. This section will introduce several potential future applications of map information created using data on the elderly.

6.1. Use of Statistical Data Obtained from Public Institutions

A large amount of data is published on a national-level by central government offices such as the Ministry of Internal Affairs and Communications and the Ministry of Health, Labor, and Welfare. Local governments (such as prefectures and municipalities) keep information regarding population statistics, social and economic information, schools, businesses, land use, roads, railways, and environmental information such as rivers. Most of this information is stored digitally and is publicly available as data processing and map creation with GIS take place when necessary.

Usage of statistical map data related to the elderly or aging societies should be re-acknowledged as an effective means of communication (for example, as presentation material). In recent years, GIS usage has also been found in the health sector (Nakaya, 2004), and within the field of gerontology. Additionally, it will likely be used in epidemiology and public health data. The World Health Organization (WHO) has proposed eight domains for the realization of elderly-friendly cities. These comprise outdoor spaces and buildings, transportation, housing, social participation, respect and social inclusion, civic participation and employment, communication and information, and community support and health services (WHO, 2007). It is expected that town planning by map creation utilizing GIS will take place.

6.2. GIS Construction and Providing Map Information Services in Local Governments

In recent years, the number of municipalities introducing GIS with the goal of efficient public facility management and window/counter service has been on the rise. When local governments manage information, such as an area's population and land use, providing information and using systems for achieving efficiency is possible. Such usage may include database searches and displays to aggregate calculations, and linking additional information to pre-existing geographic information, such as Google Maps. For example, the City of Inagi in the Tokyo Metropolitan Area offers map information called the "Inagi Map" on its website that profiles welfare, health, and medical facilities. Users can enlarge and reduce the image on their computers, and confirm a facility's location via map or photograph; they can print this image immediately.

Additionally, the City of Kobe offers a guide of various facilities on its website with the "Kobe City Facilities Map." For example, if you choose "senior life" from the main category and "facilities for the elderly" from the subcategory, over 900 registered facilities will be displayed on the map. Users can search by administrative district or keyword. Users can access the facility's basic information, and the independently produced website. Because QR codes are also included, users can travel directly to the facility while inspecting the route on a mobile device. For care and welfare services in towns and villages with low economic profitability, there is little prospect of emerging commercial enterprises. As such, the creation of health and welfare maps that can provide more efficient service will be needed (Tsubomoto & Higuchi, 2005). In addition, we expect that posting senior housing information on disaster prevention maps will help support the elderly, provide rapid response during times of disaster, and help to prevent unattended deaths after disasters.

6.3. GIS Usage in the Selection of Public Transportation Routes

According to the 2011 White Paper on Aging Society, the elderly population desire societal participation more than they did ten years ago. Approximately six percent of elderly participate in some sort of group activity (Cabinet Office, 2011). In modern society, we depend largely on public transportation when we travel. To support the social participation of elderly people in good health with a high level of independence, it is desirable for regions to provide various means of transportation and environmental improvements. These improvements enhance leisure time fulfilled by outings, and increase access to shopping and medical institutions. Therefore, in the future, it is desirable for regions to strive independently to provide services for maintaining social vitality.

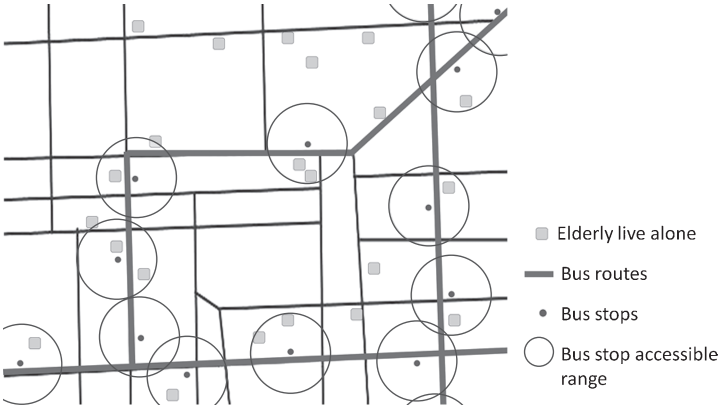

FIGURE 6.
Elderly Residences and Bus Access in the Region

When selecting flexible routes for public transportation (such as bus routes), regions must consider the residential areas of elderly people who will use these transportation routes. There must be an emphasis on convenience, especially when determining bus stop locations. For the average person, a radius of 300m from a given bus stop is considered the typical access range (Machida, 2004). For the elderly, we can expect this range to be somewhat smaller (Figure 6). Location and site conditions such as inclines and detours may also affect this range.

With regard to enacting improvement efforts in municipalities, Tsubomoto and Higuchi (2005) introduce the aging Sakuragaoka area of Tama City in the Tokyo Metropolitan Area as an example of a region using GIS. In Sakuragaoka area, they examined the dissolution of inconvenient traffic areas at the request of the citizens. Through GIS analysis, they are creating line graphs showing changes in the aging rate. In addition, they created maps comparing environment changes in Sakuragaoka and the surrounding regions. These maps also show businesses, medical and leisure facilities, and steep slopes and long flights of stairs used by the elderly near rail and bus routes and station/bus stop locations with a 250m radius. They are also investigating the demarcation of facility locations by purpose (business, medical, and leisure), transportation methods to get to these places, and distinguishing transportation methods by targeted age. Because of these studies, fixed bus routes as well as community bus routes using the highly profitable, low-floor minibuses were established.

6.4 The Use of GIS in Business Information Management and Area Marketing

As the number of elderly rapidly increases in our present era, we can consider the use of GIS can as a marketing strategy system. We commonly observe GIS use in the business field in the United States (Boyles & Harder, 2002; Thomas & Ospina, 2004). GIS in the business field, particularly in marketing, has the potential to be used as a marketing information database, marketing information processing tool, and a delivery planning support tool (Machida, 2004).

When used as a tool to target the elderly, GIS (as a marketing information database) could potentially display maps with actual data on residence distribution and family structures of elderly customers. It may also indicate the location of facilities and shops providing goods and services, and transaction data. As an information-processing tool for area marketing, businesses can use important maps for determining plans to expand existing stores and open new stores. Businesses may also adjust their services according to the needs of the region's elderly, and establish pamphlet and advertisement distribution areas for places to visit. It would also be possible to perform share analysis against competing stores. As a sales strategy, businesses can review restaurant menus and refine sales targets for things such as walkers, wheeled walkers, and home renovation supplies. As a tool to support delivery businesses, GIS could be used to plan home delivery of goods to elderly customers' doorsteps. It can also be used in the transportation of nursing services and daycare services. In GIS, there are network functions to display the shortest route between selected points in addition to alternate routes; GPS-equipped car navigation systems function similarly. In the taxi business, GPS-equipped taxi location awareness, ride situations, and dispatch arrangements are often managed centrally; this supports the transportation of the elderly to medical facilities and short distance transfers. In addition, because services delivering hot meals to the elderly must make deliveries within a certain amount of time, it could be used to calculate the required number of operating delivery vehicles.

6.5. Use of GIS as Guide and Information Services

In recent years, map information previously referenced only through paper media, is now accessible digitally through computers connected to the Internet (including mobile devices). Searches for convenience stores, banks and ATMs, and gourmet eateries are convenient and include users' comments and rankings. When searching for a restaurant using a mobile device, you can view images of the restaurant's exterior and interior, as well as food dishes. Users can view the operating hours, telephone number, discounts, and directions with their estimated time of arrival. This type of information guidance is also available for supermarkets, medical institutions, recreational facilities, and event venues such as movie theaters and museums. The information may include operating hours, wait time, and senior discounts for sightseeing destinations.

The "Kyoto Sightseeing Navigation," a mobile device service provided by the city of Kyoto, is one example of a travel guide. When you select a sightseeing course by area, course name, or departure and arrival points, and submit it via email, it will guide you to bus pick-ups and drop-offs to your destination. The service also provides a map to guide you from the bus stop to your destination, and approaching bus information. At your destination, facility overviews, nearby tourist facilities, and bus information for the next destination are available. For your health, weather guidance for mountain climbing and hiking, route guidance to rest areas, food and toilet facilities, and estimated destination travel time are also possible. Recently, GPS-equipped digital cameras using Internet-connected computers can automatically link the photograph with a map to indicate location; this has become a must-have item for travel. There is also a smartphone map search service that allows you to observe changes over time in a region; many functions useful to elderly people have been introduced.

7. Future GIS Applications

With Internet and computer performance growth and the increased prevalence of GIS, significant changes are taking place in map information creation and use situations. At present, creation of digital maps is possible for individuals without specialized knowledge. A number of portal sites enable web-based map delivery. In the area of WebGIS (web mapping), there are an increasing number of websites that enable users to provide geographic information and participate in map creation. As a result, the line between map creators and map users has blurred, and its role as a means of sharing information is strengthening. In today’s aging society, the importance of providing information through maps in numerous domains is being reconsidered, regardless of whether the elderly will become direct users of GIS. Although the convenience and versatility of maps created through GIS has increased, a number of problems remain.

First, there is the issue of whether advanced, multifaceted GIS maps are user-friendly for users unfamiliar with digital map information. Maps are a means of information transmission used daily by most people; however, even though the difference between a printed map and a digital map is a change in media form, not everyone will fully understand the map information and in particular, many elderly users have difficulty understanding the information. Although the elderly have a strong sense of orientation when compared to younger individuals, they get lost more frequently. Survey results indicate the potential for map use to mitigate the deterioration of spatial abilities with age (Wakabayashi, 2008). Therefore, if the elderly are to become map users, appropriate usage of map information can be encouraged by repeating simple training activities each day to maintain or strengthen spatial abilities. These activities may include closing their eyes and grabbing objects in front of them, imagining shapes or forms, or trying to draw a map of their neighborhood. It is necessary to account for the physiological vision changes associated with aging, as well as preferences for typeface and size. In the future, it would be beneficial to prepare learning opportunities for map information and support services systems so the elderly can utilize digitalized maps. Furthermore, in order to provide a quality user-friendly service for mobile device usage by the elderly, we must account for appropriate device size, weight, screen size, font style, and color. In addition, in different situations, it may be necessary to enhance facilities with mobile devices.

With regard to the information provided by GIS maps, more accurate and qualified information aligned to users’ needs is required. For example, does the map provide an appropriate level of detailed information? To overcome these issues, map design with consideration of cognitive processes during use is necessary. Although there are a variety of possible representation methods during map creation (e.g., using symbols, hues, and graphs), creative solutions for consistent usage of these patterns and map deformation tailored to the map's purposes and users is needed. In addition, the most valuable method would be to consider whether to include pie charts or line graphs on the map. If included, which would be appropriate, and subsequently creating map information tailored to the situation.

As GIS software operation becomes easier, there are both adverse and unexpectedly positive effects. First, creation of a meaningless statistics map occurs when a GIS user lacks basic knowledge of maps and data analysis, and without an understanding of the software functions and features. Akimoto (2004) notes many cases in which GIS users create maps without awareness of appropriate data usage. If the aforementioned map information becomes publicly available, there is a danger that users will not understand or be confused by the information from the map. Alternatively, the power GIS exerts when used as a research tool for hypothesis construction, rather than for hypothesis testing, has also been noted (Yano, 2005). In other words, instead of forming a hypothesis from survey studies and testing it with GIS, an inductive approach is considered effective. In this manner, one would use GIS to make an accidental, meaningful discovery from a large amount of pre-existing information, and then form a well-organized, conceptual hypothesis. As such, while there are problems using GIS vaguely, there are also potential advantages of its use.

Further advancements are predicted in map information research will likely continue in the future. These advancements include audio guidance, and discussions regarding shared information (including standards and versatility, particularly in regards to the integrity of the data available for processing). As for usage of geographic information in gerontology, we anticipate further development and broader utilization from future applications. By utilizing a combination of the developments of GIS as both geographic information science and an interdisciplinary approach focusing on the elderly and aging societies, we hope this will produce a synergistic benefit. These benefits will not be limited to the research field, but will extend to the creation of an elderly-friendly society.

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