デジタルデザインによる地域計画を半自動化するGISデータベースの開発
-静岡県裾野市の計画事例をもとに

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Development of A GIS Database to Support Regional Plan through Digital Design
- Based on the Planning Cases in Susono, Shizuoka Prefecture

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The aim of the present study is to prepare a GIS database on regional planning to access the useful index and features for simulation model in digital design work as well as the similar cases data for reference. The GIS database was developed from multi-source and multi-type datasets. Based on two regional planning cases: the New Fukara Station project and New Hiramatsu Fukara Line project in Susono, Shizuoka Prefecture, we developed the model for simulating the planning process, for which the database is working to support the digital design and cost & effect calculation. The land purchase scenario and land readjustment scenario were designed for different regional development approaches. This paper describes the data and method used to produce the database, and represents the model linked with it. The result intends to be significative for improving the efficiency of citizen communication and regional management.

Keywords: データベース（Database），デジタルデザイン（Digital Design），地域計画（Regional Plan）

1. Introduction

In recent years, the Japanese national government and local governments have been faced with a need to implement the compact city policy, in response to the social changes in Japan, such as rapid population decline and aging problem(MLIT 2015). Therefore, it will be important to create a high quality and efficient urban environment for citizens in the future. In the current urban area, there are many districts with poor urban infrastructure and low usable value. The urban development methods such as land readjustment projects and urban redevelopment projects are utilized to deal with these issues and try to transform the urban structure into a compact one.

For urban development projects, it usually takes long time and plenty of money in feasibility study phase(事業化検討段階) for research and designing work, whichever the project type is. There are several procedures before the project has been determined. The implementor need to do survey in target area and communicate with stakeholders for draft plan making and budget calculation to get the permission of national government (公益社団法人街づくり区画整理協会 2019). Meanwhile, it is necessary to take the reflection opinions of residents by holding public explanatory meetings and announce the draft to landowners. After the approval of project, the detail of fund plan and land exchange plan will be decided after discussion. Thus, in the preparing and planning stage, we believe that it will be efficient and helpful if there is a regional plan simulation tool for implementor to quickly produce the draft plan and budget. In our previous research, we designed a prototype of the regional plan simulation tool based on one case study in Shizuoka Prefecture.

For improvement of gathering datasets sharing with citizens and urban simulation working on compact city

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policy, Hasegawa, et al. developed a web-based urban communication tool using open government data(Hasegawa, et al. 2019). For supporting the research in urban planning, Kitano, et al. created a GIS database system for Kanazawa city by collecting various statistics dataset including population, land use, transportation, topography and so on(Kitano, et al. 2001). Asano and Kosako also developed a diachronic database for city planning using GIS for Hokuriku-Ko-Shin-Etsu region in order to preserving the city planning map and observation(Asano and Kosako, 2009). In this paper, we describe the development of a GIS database for supporting the digital design process and implementing our regional plan simulation tool all over Japan in the future.

2. Research Structure

2.1 Storage of Data on Regional Plan in GIS

The multi-source and multi-type planning case data were collected and be organized into GIS dataset, then a DB was created along with the basic infrastructure GIS dataset. It will be possible to use this DB to find similar case information as reference when considering plans for new regional development project in other districts. Also, the basic infrastructure GIS data for each prefecture enable the simulation tool to be implemented in any location over Japan.

2.2 Study on Index of Model for DB Accumulation

For Japanese land readjustment project, the land exchange design is an important part in project preparation phase. The standard land area of each lot inside the project region should be measured as an original data. Then the land estimation will be done for the calculation of compensation, the size of replaced land and reserved land. Based on the calculation result, the location, size and shape of replaced land will be preliminary designed as a tentative plan. Our model simulates the land estimation stage through a digitalization of its calculation. As the parameters of index in the model usually determined by multiple conditions of lot, it is a great solution to import the parameter selection condition into DB for invoking by the model. The detail of index will be described in 3.2.

3. Building Regional Plan DB

3.1 DB System and Creation Procedure

In order to make all the dataset into one DB, the multi-source data were collected and be classified based on their type, including polygon data, polyline data, point data, and other text data pick from documents. Then those organized data were uploaded into a PostgreSQL DB. We choose this system because there are both spatial datasets and non-spatial dataset. PostgreSQL can satisfy the storage and edit of GIS data by PostGIS service and easily visualize in QGIS. After the DB was created, it can be connected with the calculation model we developed for regional plan simulation. The simulation model in this research is created in Python language on Jupyter Notebook. The data required in calculation can be called and the result will be wrote into the DB. Figure 1 shows the creation procedure of the DB development.

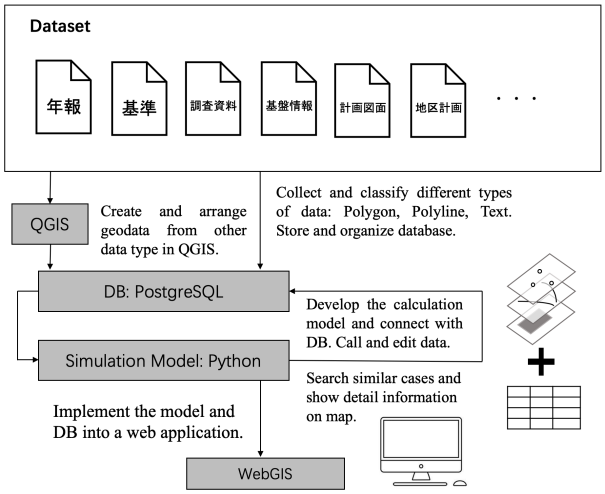

Figure 1 Creation Procedure of Regional Plan DB

3.2 Data Sources

The majority of the datasets were obtained from commercial vendors or incorporated associations, or extracted from open data(Figure 2). The building dataset was derived from Zenrin Co., Ltd. The land use dataset was derived by Geospatial Information Center by extracting from Basic Urban Planning Survey dataset. As our regional plan simulation model is designed in vector-

base so even the mesh-base land use dataset is provided as open data by national government, we employed this disaggregated land use dataset. Those basic infrastructure dataset used to derive the DB are contained in Table 1. This DB is designed to be implemented all over Japan while until now the open data are only available in limited prefectures. The basic unit for simulation in our model is lot, while not all the land use data is provided in lot-base, we use a lot cutting algorithm to create the pseudo lot data for applying the simulation model, which will not be described in detail in this paper.

The Annual Report Dataset of Urban Readjustment Projects was obtained from The Land Readjustment Center, in which the data related to nationwide land readjustment project approved from 1970 to 2020 were statistically organized, the total amount of project is 8736 . It is an excel file comprehensively contains about 143 items of data related to the projects, from project specifications such as area name, reduction ratio to the type and characteristics of the project. However, the geographic information of each case are usually shared in local governments' website as project report. We extracted those geographic data to link with map information and statistics table data by Qgis then imported into DB by PostGIS service. The following project statistics(Table 2) are included in the DB.

The book "Land Readjustment Project Practical Standard"(公益社団法人街づくり区画整理協会 2019) defined the detail of method for land estimation including the calculation of street value index, blcok evaluation, land use improvement ratio, lot evaluation, right price ratio and price per index. For the calculation of each index in the method, there are several parameters defined to be determined from the attributes of the lot. Table 3 shows the parameters we imported into the DB learning from the Practical Standard book.

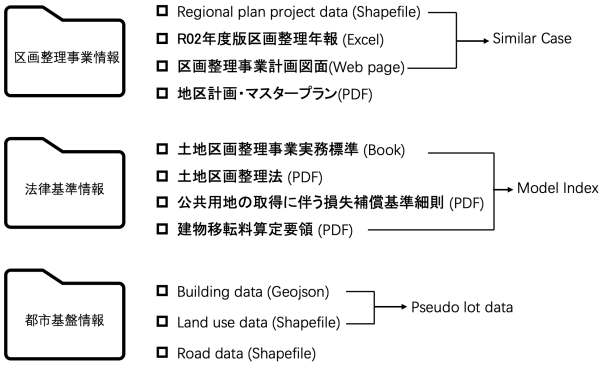

Figure 2 Data Content in DB

Table 1 Basic Infrastructure Dataset List

Prefecture	Building	Land Use(Year)	Prefecture	Building	Land Use(Year)
北海道	●		滋賀県	●	
青森県	●		京都府	●	
岩手県	●		大阪府	●	
宮城県	●		兵庫県	●	●(2014)
秋田県	●		奈良県	●	
山形県	●	●(2017)	和歌山県	●	
福島県	●		鳥取県	●	
茨城県	●		島根県	●	
栃木県	●		岡山県	●	
群馬県	●	●(2017)	広島県	●	広島市(2015)
埼玉県	●		山口県	●	
千葉県	●		徳島県	●	
東京都	●		香川県	●	
神奈川県	●		愛媛県	●	
新潟県	●		高知県	●	●(2014)
富山県	●		福岡県	●	
石川県	●		佐賀県	●	
福井県	●		長崎県	●	
山梨県	●		熊本県	●	●(2015)
長野県	●		大分県	●	
岐阜県	●		宮崎県	●	
静岡県	●		鹿児島県	●	
愛知県	●	名古屋市(2016)	沖縄県	●	
三重県	●				

Table 2 Project Statistics

Attribute	Unit	Attribute	Unit
ID		施行前合計面積	ha
都道府県		施行後公共用地面積	ha
市町村名		施行後宅地面積	ha
施行地区名		施行後保留地面積	ha
施行者種別		施行後合計面積	ha
事業面積	ha	国庫補助	百万円
公共減歩率	%	都道府県単独費	百万円
保留地減歩率	%	市町村単独費	百万円
合算減歩率	%	公共施設管理者負担金	百万円
施行前地区内人口	人	保留地処分金	百万円
地区内計画人口	人	その他事業費	百万円
土地所有権者数	人	収入計	百万円
借地権者数	人	公共施設整備費	百万円
施行前市街化率	%	移転移設補償費	百万円
現況建物戸数	戸	減価補償金	百万円
要移転戸数	戸	その他工事費	百万円
減価補償金地区		その他事業費	百万円
施行前公共用地面積	ha	支出計	百万円
施行前宅地面積	ha		

Table 3 Parameters in DB

Index	Parameter	Description(公益社団法人街づくり区画整理協会 2019)
街路係数	t	市街地の街路網における当該街路の交通上の性格、系統性及び連続性等道路の等級を表す指数。
	X	街路のスペース機能及び整備水準による宅地の利用価値・効用を表す。
接近係数	m	対象施設から受ける又は受損価値の大きさを表す係数。
	S	対象施設の影響距離限度。
	R	定位距離。
	n	影響力の逓減する割合を表す係数
宅地係数	u	地域の条件、土地利用の用途、ロット割による建築密度、商業ポテンシャル 及び市街地形成熟度との関係で定まる宅地の一般的利用性の基本的等級。
	P_0	基準公共用地率でその標準値。
	Q_0	基準道路密度でその標準値。
	Y	供給処理施設の整備状況等、宅地利用に直接影響する物理的条件によって付加された価値・効用を表す係数。
側方加算指数	側方加算率	
背面加算指数	背面加算率	

4. Implementation of DB in Case Study

Now the Regional plan DB work with our simulation model has been applied to two real project cases in Susono city. Susono is a local city with nearly 51 thousand population(2020) in Shizuoka prefecture, Japan, which is now suffering from the problem of depopulation and aging. The simulation model was developed based on the working methods of land readjustment project determined by national government. Different types of projects approach in different methods. Figure 3 shows the model structure of road improvement project case in land purchase scenario while Figure 4 shows the case of new station project as examples.

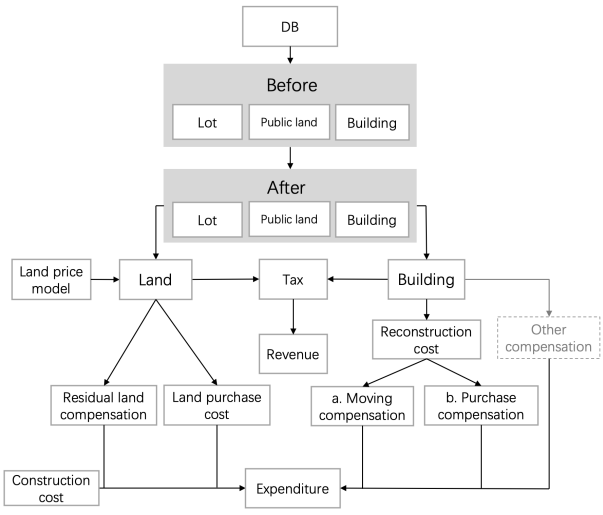

Figure 3 Model structure of Road Improvement Case

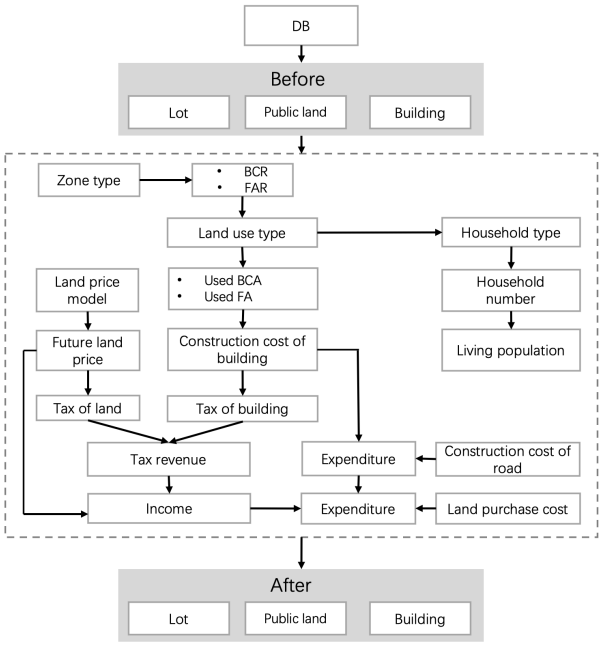

Figure 4 Model Structure of New Station Case

4.1 Case 1: New Hiramatsu Fukara Line Project

The city plan road improvement project has been proposed in Susono city since 2007 for a safe and comfortable urban development. Until 2018, the 62% of project has been finished while the Hiramatsu Fukara Line part is currently under construction. In this project, the part of Hiramatsu Fukara Line in Fukara region will be built as a new road.

The road project in Japan usually develop in two methods(MLIT 2008). One is the land purchase method, in which the land planned to transformed to new road will be simply purchased and the other part will be left in its original state. The other is land readjustment method, which means the whole project region will be reorganized in better way to fit the new road, each lot will be changed to a new form and contribute for the additional road area. The differences of these two methods covering the project cost, land rights and urban morphology. So in the simulation model, we developed these two scenarios to forecast the project cost and effect.

As the model structure described in Figure 3, the basic infrastructure data is obtained from DB at the beginning. Then the new road can be created as a polygon with the GUI of our web application. The basic information after

the project can be calculated with the simulation result of cost and tax effect.

The similar cases are collected by selecting the land readjustment projects with the application of soft method(「沿道整備街路事業(沿街)」). The search result shows it has been 39 similar cases in Japan and 27 of them are available in our DB. Figure 5 shows a sample of case data in DB.

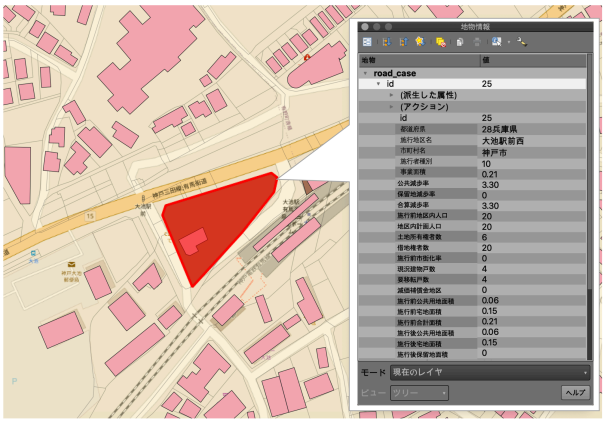

Figure 5 Sample of Case Collected in DB

4.2 Case 2: New Fukara Station Project

In the Fukara region of Susono, the new urban area concept has been continuously proposed starting with the submission of a petition for the establishment of a new Fukara station to the city council in 2005. The regional master plan and zoning have been proposed based on the previous workshop with habitants. Our simulation model works from a basic data reading by DB, ss Figure 4 shows the model structure of this case. Based on the information from the master plan and zoning image, the zone type is selected by user(Figure 6) and appears in different color. Then Automatically Locate action will present the block form and users can input the setting of land use ratio for each block area(Figure 7). The result of cost & effect calculation will be show in Automatic Placement action (Figure 8) reading from the DB. Users can see the detailed information of each lot, including basic lot information, construction cost, future population and so on. Here, the building coverage ratio and floor area ratio can also be adjusted by users to simulation the cost & effect result in different situations. Finally, the 3D model will be created(Figure 9).

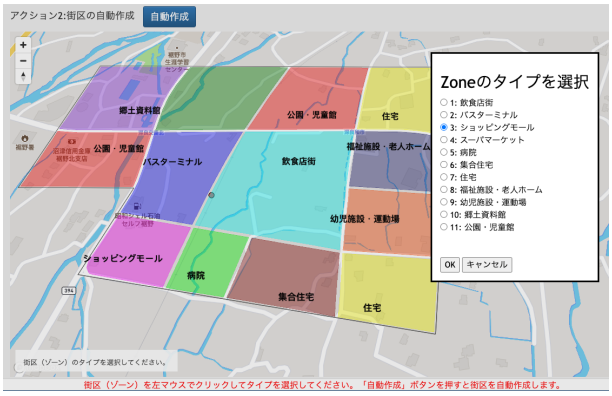

Figure 6 Action 1: Zoning

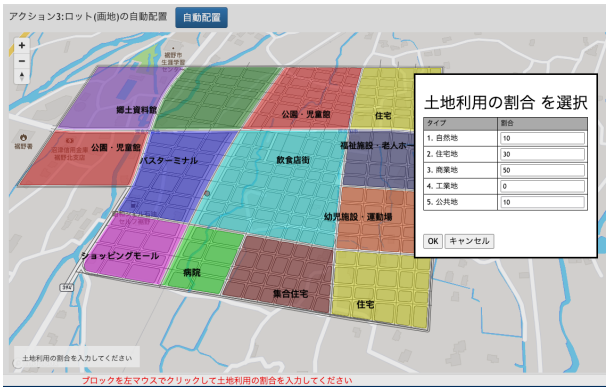

Figure 7 Action 2: Automatically Locate

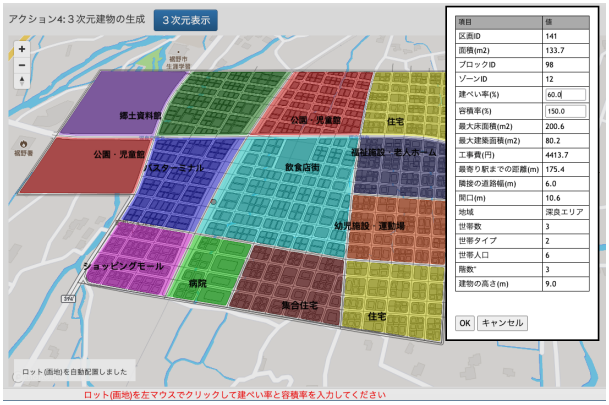

Figure 8 Action 3: Automatic Placement

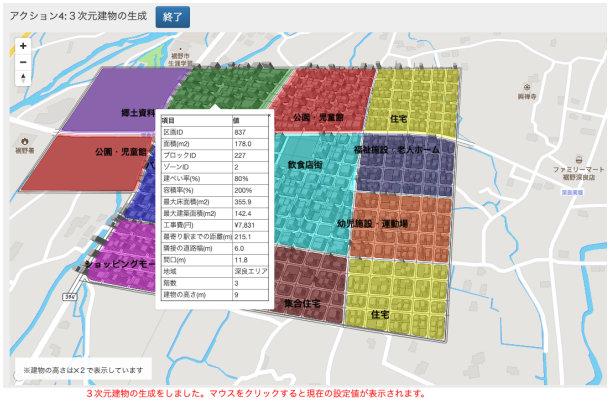

Figure 9 Action 4: 3D Model Creation

5. Conclusion and Future Work

This paper described the development of the regional plan database in Japan for narrowing down the digital design process. The database provides a comprehensive coverage of basic infrastructure, urban readjustment project cases, and reference information of Japan cities for use in regional plan simulation model. The database working with the prototype of regional plan tool can function without collecting from different departments as the basic dataset used for simulation is equipped. The calculation models for different types of project are uploaded for quickly access the budget and project effect approximately. Managers can make a rough estimation of regional plan without field measurement and stakeholder surveys then used it to communicate with residents. The similar cases are categorized and accumulated in this database in order to be taken as reference for new projects. All of these work contribute to streamline the project preparation phase while spending less money and time.

However, this time we took two cases on trial for verifying the regional plan database working with the simulation tool. The diversity of regional plan work makes it necessary to do more experiment in different types of cases in the future to approve the database and model step by step. And the previous data related to different types of case should also be accumulated.

As the DB is designed for simplifying and automating the digital design process in the beginning of regional plan project working with our simulation tool, it will be valuable to practice with regional managers and try out in citizen collaboration occasions for testing the effectiveness and getting feedbacks. We plan to put them into real citizen collaboration occasions in Susono city and get feedbacks from residents and managers in the near future.

Acknowledgment

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