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Generic Strategy for Protecting Safety and Society by Using GIS
- Combat GIS Based on Enterprise GIS -

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Synopsis

We are exposed to various kinds of Multi-hazards due to natural disasters, terrorist attacks and epidemic's outbreak. In any of these crises, national and local governments have to implement emergency response and management effectively. Since Hanshin Awaji Greate Earthquake, GIS was recognized as powerful tool for disaster reduction and many GIS systems have been introduced by local governments for disaster management bureau. These systems are tools for estimating damage, and GIS is not still used well post-event consequence for management considered on disaster management cycle. In this paper, we introduced as a Combat GIS comprehensive emergency management system based on GIS. In other words, Combat GIS is a system that aims at utilizing GIS in the area affected emergency for local governments, and helping emergency response and management even if anywhere, anytime, any kinds of crisis occurs. CombatGIS makes use of integrated Enterprise GIS as information infrastructure for local government and compose of hardware, software, database, geospatial data, organization and people. In Japan, most local governments introduce GIS system as stand alone for routine work and GIS is not utilized common tool. In this paper, I show a strategy to construct Enterprise GIS and implement to utilize GIS for emergency response and management at some events at city of Uji, Kyoto Prefecture, Japan.

Keywords: WTC, 9/11, Emergency Response, NYC Disaster, GIS

1. Introduction

We are exposed to various kinds of Multi-hazards due to natural disasters, terrorist attacks and epidemic's outbreak. As for earthquake, we suffered intensive damage by Hanshin Awaji Great Earthquake, 1995 and Great Kanto Earthquake, 1923, and we have report that Nankai, Tonankai and Tokai earthquake will occur in near future. In this situation, local government implements countermeasures such as construction of physical facilities in order to enhance potential of disaster mitigation, making disaster mitigation planning and recovery planning and table top exercise. These efforts are focused single hazard and it is insufficient to manage various kinds of hazards. We are needed to improve of an ability of crisis management against various hazards, which is the way to reduce damage and to recover as soon as possible as it was. A common subject for a crisis management is said as measures for saving life (Emergency Response), restoration of a social flow, the rebuilding of social stock and logistics to manage resource and information. In order to improve the ability of crisis management for local governments, it is crucial to improve the ability of information processing to grasp the situation summary now goes on in the affected area by crisis. Therefore, GIS system for disaster mitigation was introduced by many local governments. Since Hanshin Awaji Greate Earthquake, GIS was recognized as powerful tool for disaster reduction and local governments have introduced many GIS systems. These systems are tools for estimating damage, and GIS is not still used well post-event consequence for management. In this study, we introduced as a Combat GIS comprehensive emergency management system based on GIS. CombatGIS makes use of Enterprise GIS as information infrastructure for local governments. This paper shows a strategy to implement Combat GIS and aims at contributing to

keeping security / relief of people.

2. Outline of the Study

Firstly, I examined as successful events by using GIS that are NY World Trade Center September 11, 2001 and Southern California Wildfires, 2003 for crisis response and management based on GIS. Though these events, GIS for crisis response and management is to use GIS based on "Enterprise GIS", organize critical data (Lifeline, etc.), share data with security, develop modeling for loss estimation, provide information (map) in a timely manner, gather data in real time after the event, prepare data backup and cooperate among organizations for using GIS. Combat GIS will be used GIS as common tool, support various activities after the event on-site and compose of technical GIS for crisis response and management and Enterprise GIS. Enterprise GIS compose of information infrastructure, GIS software, data, application, organization and people. As strategy building Enterprise GIS, I suggested Enterprise GIS focused on sharing information for light users who use GIS lightly. This strategy is to create new business model for Enterprise GIS and leads to set the GIS environment to implement Combat GIS in our society. At city of Uji, we had serious incidents. Suspicious individual injure children in elementary school. GIS application consortium already has been composed of various kinds of organizations and is held one for a month since couple years ago at Uji region. This consortium has already developed interactive GIS application for e-town Uji for sharing information among citizens and we improved this system to the interactive GIS system named as " Uji Safety and Society Map" within one month after the event. This system will store information that children has "Hiyari" and"Hatto" experiences by using web GIS technology. Further more, February 2004, the bird flu outbreak occurred in our neighborhood and the damage expanded along the chronological order. To grasp the chorological changing of situation, I created map template and provided map by Internet. These efforts of my study are practical process for Combat GIS and it is crucial that staffs of local governments attend the process deeply to build an Enterprise GIS and they can have data, system, experience and knowledge due to make use of GIS effectively in local government.

3. Practical Examples of GIS in Crisis Response and Management

In Japan, there is not the success example that utilized GIS for crisis response and management. Firstly, I examined two examples (NY World Trade Center, Terrorism Attack, September 11, 2001 and Southern California Wildfires, 2003).

3.1 NY World Trade Center, Terrorism Attack, September 11, 2001

This event made us recognized that GIS was powerful tool for crisis response and management. The Office of Emergency Management collapsed along with the twin towers. All of the Communications, Command and Control systems for the Emergency Operations Center went down. GIS was used to support the crisis response and management. GIS was used to grasp current situation immediately using overlay function. GIS was used to support rescue efforts for avoiding secondary disaster. GIS was used as a powerful tool for visualization and analysis using 3D data. GIS was used as spatial modeling tool. One of the most difficult tasks during a complex emergency understands how things were or where things were before the event. The key was to grasp the situation by using overlay as fundamental functions of GIS. The Urban Search and Rescue Teams used GIS and image to assist the search and rescue efforts. Grids were set to support many kinds of activities which are mapping hazards and mapping the scene. For the Urban Search and Rescue Teams, they created map of ground plan that shows areas searched, areas flooded, areas collapsed and voids that might have provided an area where people could have survived. LIDAR was flown regularly to determine how the pile was moving. The color coding denotes elevations. Movements in the pile could indicate potential danger areas or where fires continued to burn under the pile. The Consequence Assessment Tool Set was used to model the flow of the plume for dust, plaster, asbestos and other materials. At this event, GIS was used various crisis response and management, but several days after 911, organizations related this event had much difficulty to set base map as shown Fig.1. FEMA got GIS contact list 3 days after the event and supported various activities by temporal staff. NYC was assigned GIS staff more than 35 people for long term after moving to Pier 92.

3.2 Southern California Wildfires, 2003

In the fall of 2003 Southern California was devastated by a number of wildfires pushed by Santa Ana winds. Using GIS at this event is more advanced than WTC 911 and GIS efforts organized by MAST were effective for disaster response and management. Mountain Agency Safety Taskforce（MAST）is organized by 14 Government agencies, 5 private companies. They spent 18 months advance planning and 6 months advance database building for fire season. MAST GIS mission is organized under Unified Command (ICS), developed Incident Objectives, utilize GIS to analyze problems and develop solutions, develop evacuation routes, evacuation centers safe areas, staging areas, base camp locations, ICP's and other facility locations, determine priorities for tree removal and locations for

disposal and provide an interactive web-based mapping system for the public. Wildfire occurred at 4 Counties (Los Angels, San Bernardino, Riverside and San Diego) at the same time. San Bernardino and Riverside County organized MAST in advance. Evacuation plans were predetermined based on a variety of potential scenarios. Hazards of fire map provided citizen by using web GIS. Fire progression by date is created map and estimate expansion of fire. GIS proved to be invaluable for public and high level briefings. GIS is the best technology for quickly providing with the information they need. Obviously MAST's efforts reduced damage by wildfire. Compare damage at San Diego and San Bernardino, San Bernardino area prevented fire along the boundary of urban area as shown Fig.3.

Through two events, we learned some critical point GIS for crisis response and management as follows:

1. Using GIS based on Enterprise GIS
2. Organize critical data (Lifeline, etc.)
3. Sharing data with security
4. Modeling for Loss Estimation
5. Framework to provide information (Map) in a timely manner
6. Gather data in real time after disaster strikes
7. DataBackup,
8. Cooperation among organizations for using GIS.

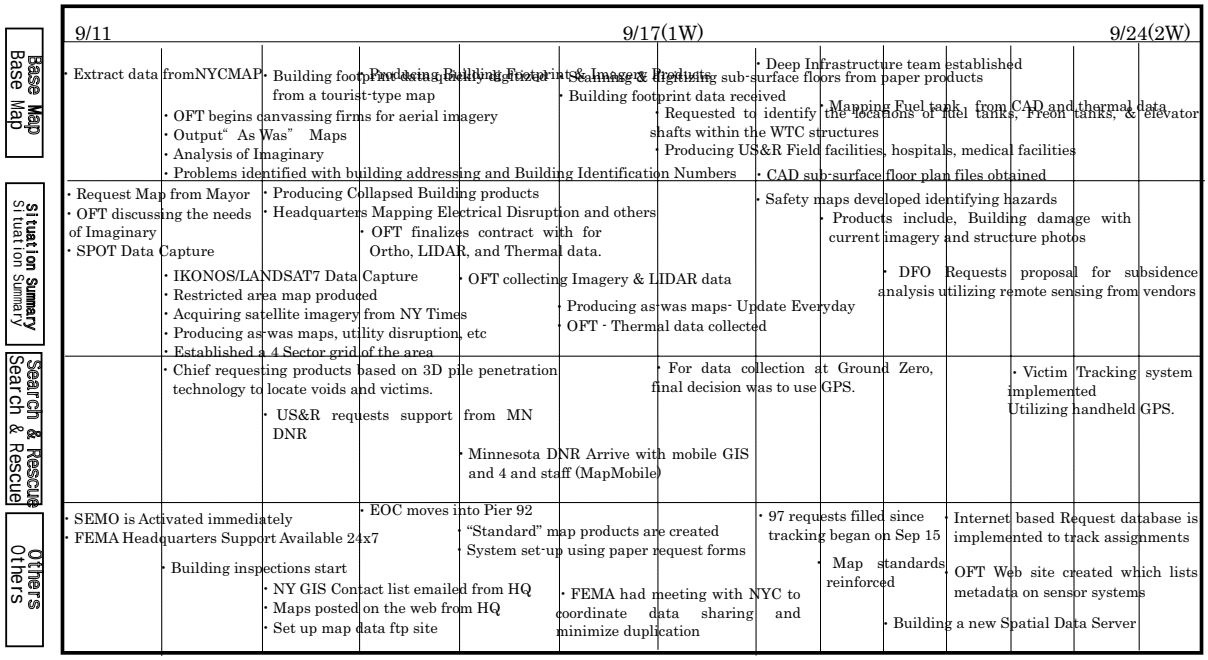

Fig. 1: WTC GIS Chronology

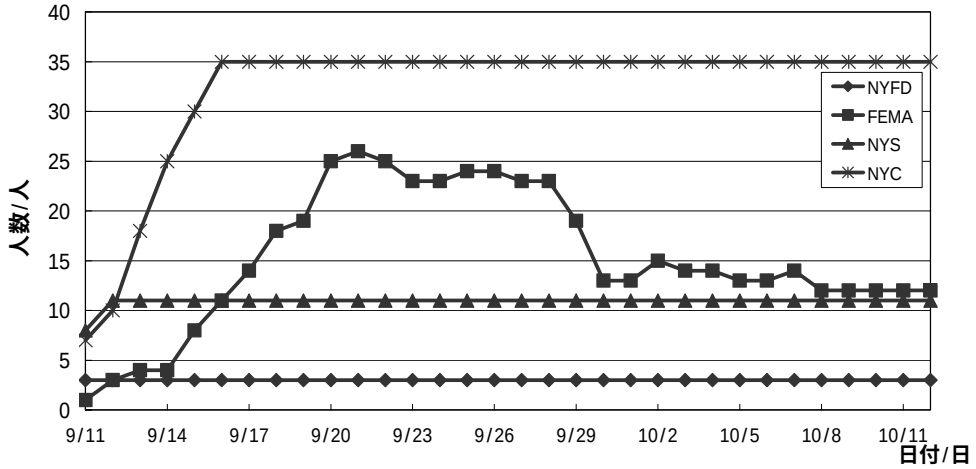

Fig. 2: WTC GIS Staff

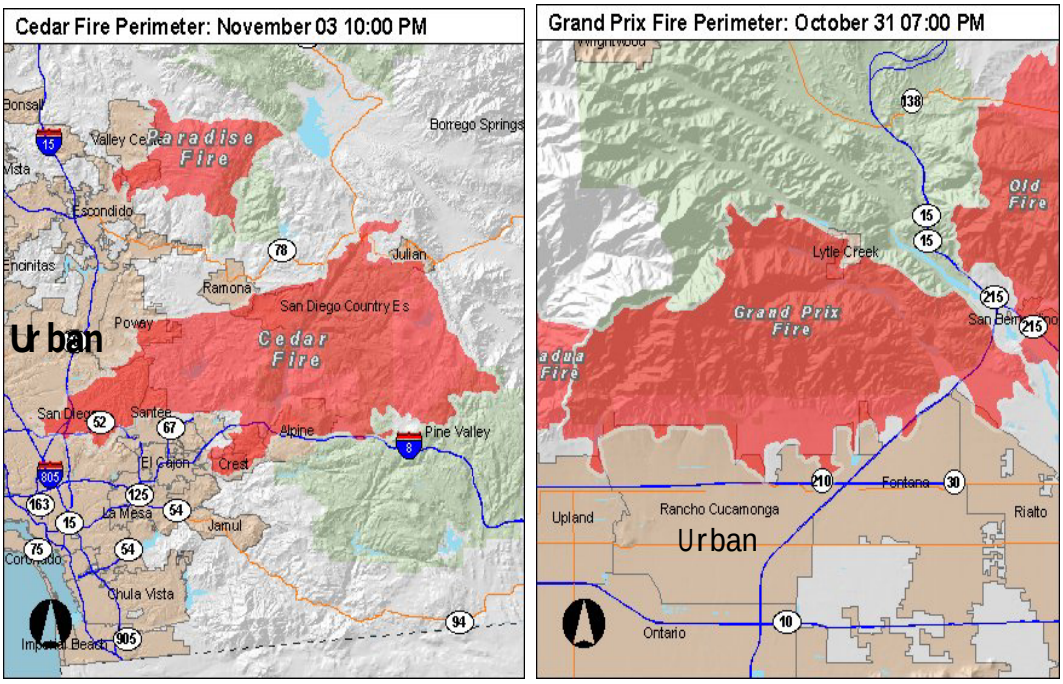

Fig. 3: Comparing Damage of Fire

4. Combat GIS and Enterprise GIS in Japan

4.1 Combat GIS

Combat GIS is used GIS as common tool and support various activities after crisis occurs on-site for local government.

Combat GIS's functionalities are:

A) Grasp the ever-changing scene of a situation in stricken area using GIS

B) Support crisis response strategically and effectively

C) Utilize GIS simulation to help crisis response

D) Share information among crisis related organizations and provide information effectively to citizens

E) Build a central information sharing system

These five points are divided into special technology for crisis response/management and extensional structure of routine works in usual. A), B) and C) are special technology for crisis response/management such as mobile device for collecting information in field, remote sensing for analysis of real time data and simulation for predict expansion of damage. D) and E) are things which local government makes use of GIS to share information and involves base map, data set, spatial database and map template.

Combat GIS compose of GIS for crisis response/management and Enterprise GIS. Combat GIS have to run in every phases of crisis management cycle. (Mitigation, Preparedness, Emergency Response, Recovery) After emergency occurs, local governments face to have to implement inexperienced new decision and task. Whenever they implement new tasks, they will almost make use of map. Combat GIS should be organized by integrated emergency management system like Incident Command System.

4.2 Enterprise GIS

As mentioned above, when local governments face crisis, they will want to use most fundamental GIS function for crisis management as soon as possible. In other words it is asked whether local government can have fundamental physical strength based on GIS.

Information infrastructure for sharing information by using GIS is Enterprise GIS itself, which involves some factors as follows.

- Information Infrastructure (Hardware, OS, Network, etc.)
- Software(GIS Software, WebGIS Software, Database: RDBMS, GIS Database)
- Data (Base Map, Layers, Interoperability)
- Application (Web Application, etc.)
- Organizations (Cooperation among Bureaus for Using GIS)
- People (Knowledge ,Skill and Commitment)

Basically, the purpose of Enterprise GIS is to organize the environment about GIS infrastructure, sharing data, establish framework to manage Enterprise GIS and enhance the service for citizens. In addition to these efforts, people will grow by building and managing Enterprise GIS. Some local governments introduced GIS System to integrate each bureau, but main purpose is to share information among GIS heavy user. Heavy users mean users who usually use GIS in routine work such as bureau of civil engineering, urban planning and tax. Some cities had great efforts to introduce integrated GIS system. I had interviews to some pioneering

governments about their GIS efforts. As shown Fig.3 the important factors to introduce integrated GIS system are cost, accessibility and base map. Especially, every city spent much cost to create base map. If many local governments can spend much resource such as budget, time and people, they can build Enterprise GIS making it sample. In fact, it is difficult to do as ever for others. Crisis is not a choice of place, so we think we must make success sample of Combat GIS. Especially, cities has less than 200 thousands population are about 97%, we had better make success sample at middle or small scale cities and expand all over Japan.

In this study, we selected city of Uji, Kyoto as study field. (Population: 188,332 ：H14,April) and I attend process building Enterprise GIS. I noticed that we need to build Enterprise GIS focused on sharing information for light users for Combat GIS. First step is to organize framework to share information by using WebGIS. Though accuracy of base map and functions of system is inferior to Enterprise GIS for heavy users, this approach can be built fundamental environment for using GIS. Under the concept "Map Communication Uji", we try to organize GIS committee which compose of many bureaus, decide base map and create system design. I am joining to build Enterprise GIS practically at Uji and the vision of Enterprise GIS at Uji is illustrated as Fig.3. This practical effort is to create new business model for Enterprise GIS and leads to set the GIS environment to implement Combat GIS in our society.

Some bureaus of city of Uji already have introduced GIS system as a standalone system, but they haven't had base map, database and commitment for sharing. Information technology promote bureau had commitment that they must change GIS environment at city of Uji. I joined this project and surveyed the current using of GIS. In the process of Enterprise GIS, we decided some important factors. A: Concept- We created that our concept of Enterprise GIS is "Map Communication Uji" and aims to communicate among each bureau and citizen.

B: System Design- The system is based on WebGIS and we build it for light users and citizen.

C: Base Map- In first introduction, base map's accuracy will not be high. Base map is directly related to cost, so after many persons use this system, we must discuss second step for heavy users.

D: Sharing Spatial Database- The function of Database for Enterprise GIS is versioning and security for multi-users.

E: Organization: Meeting among light users and heavy users is held and discuss what Uji need to GIS. In fact, each bureau didn't know what they work by using map next door. This meeting is good opportunity to know others and communicate each other.

F: Cost: An initial introduction cost should be low. Uji will introduce Enterprise GIS one- tenth to others I interviewed

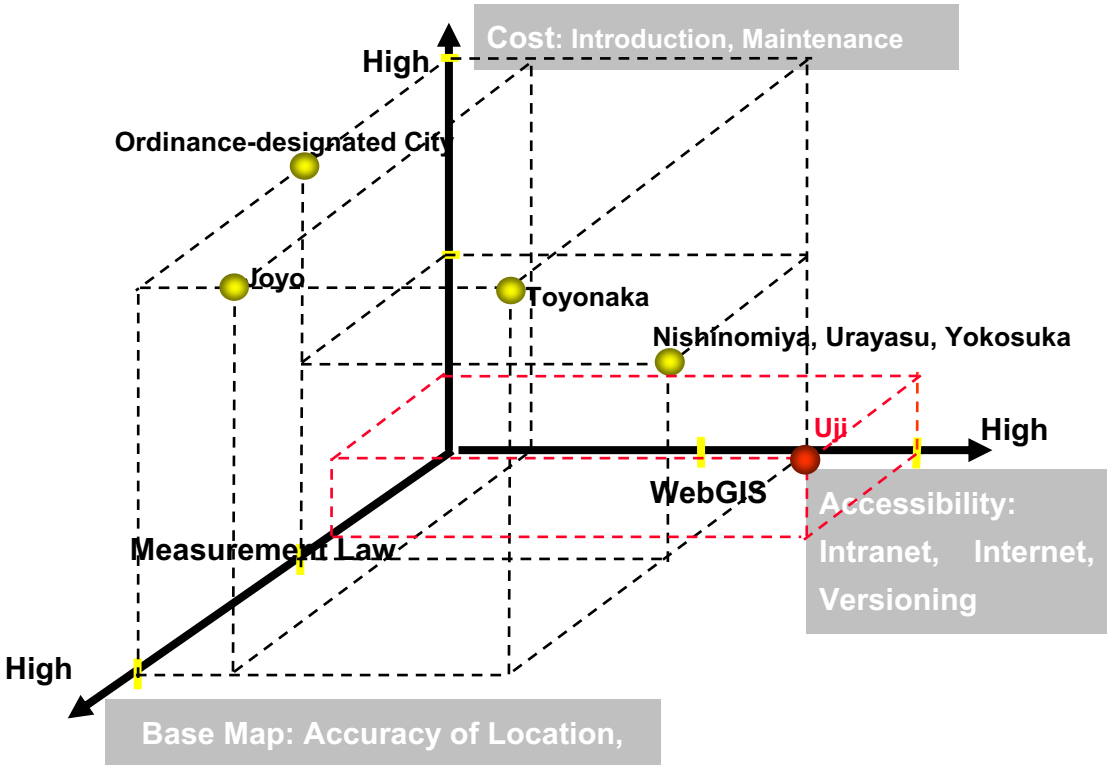

Fig. 4: Uging GIS of Local Government

5. Implementation of Combat GIS

In the middle of building Enterprise GIS of Uji, we had serious incident. Injury case to children occurred at Uji Elemental School at December 18, 2003. GIS application consortium has composed of various kinds of organizations(City of Uji, Kyoto Univ. and private companies) was held one for a month since couple years ago . This consortium has already developed interactive GIS application as e-town Uji as shown Fig.6 for citizen and we improved this system to the interactive GIS system named “Uji Safety and Society Map” within one month after the event. This system will store information that children has experienced “Hiyari”,”Hatto” by using web GIS. Citizens can input spatial data, text and image, and we check and update information. Citizens can know the location and the information related safety for children. In spite of our effort, input data is empty from citizen now, but we peruse education section and store information they manage as paper information and also advance system using cellular phone more useful for citizen.

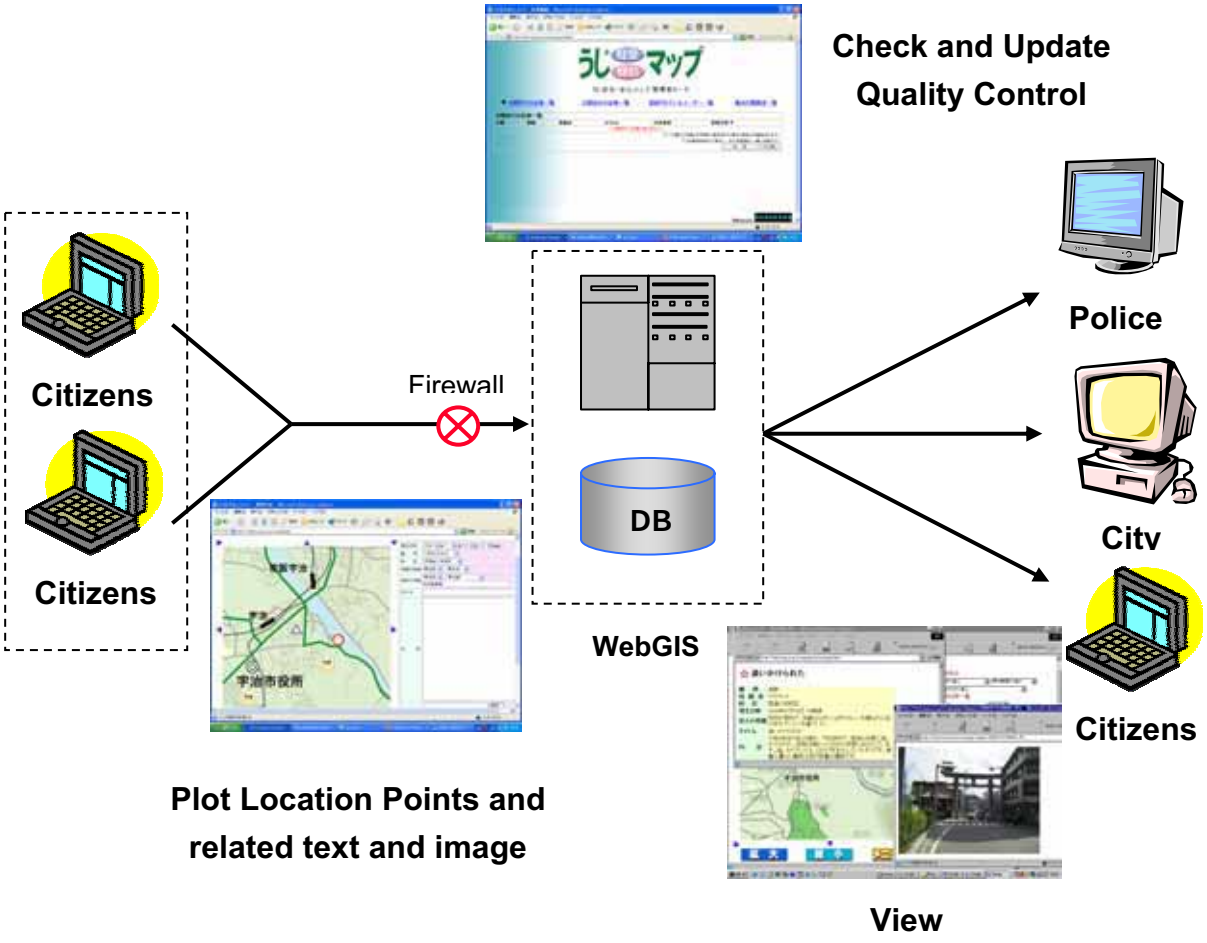

Fig.5: Outline of System

Fig.6: View of e-town Uji

Fig. 7 : Entrance View

Fig. 8 View Window

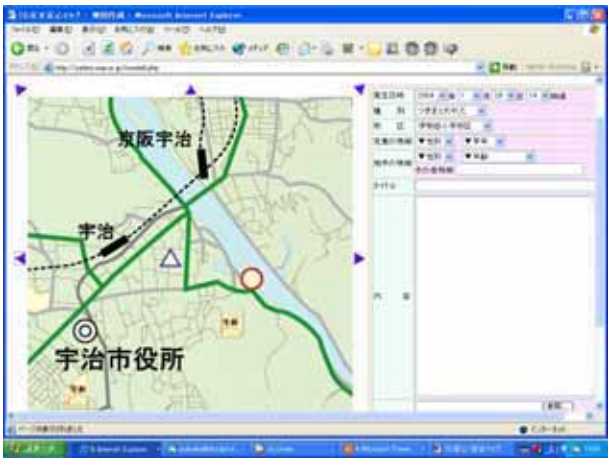

Fig.8: Data Entry Window

Next crisis was the bird flu outbreak on February 2004. In our neighborhood, the damage and influence expanded along the chronological order. This crisis was first experience in Japan and damage expanded as follows.The Bird Flu (Type H5N1) was detected in Tanba, Kyoto Prefecture. (2004/02/29), The Bird Flu (Type H5N1) was detected at another farm near outbreak farm. (2004/03/03) , A Crow infected the Bird Flu and was dead near outbreak farm and two crows infected were found at Sonobe next town to outbreak farm. (2004/03/07), A crow infected was found at city of Ibaraki, Osaka Prefecture. (30km from outbreak farm: 2004/03/11), Two crows infected were found at city of Tanba, Kyoto Prefecture. (10km from outbreak farm: 2004/03/13)

Local governments restricted not to move chickens outside 30km and must clean up farmers in neighborhood. In this event, I create the map we can understand the situation summary changing day after day as shown Fig.9. This effort is focused on sharing information after event occurs. At this event, main bureau was not heavy users like urban planning, tax and civil engineering and no local government use GIS effectively. But this event made us learn the importance of Enterprise GIS for light users.

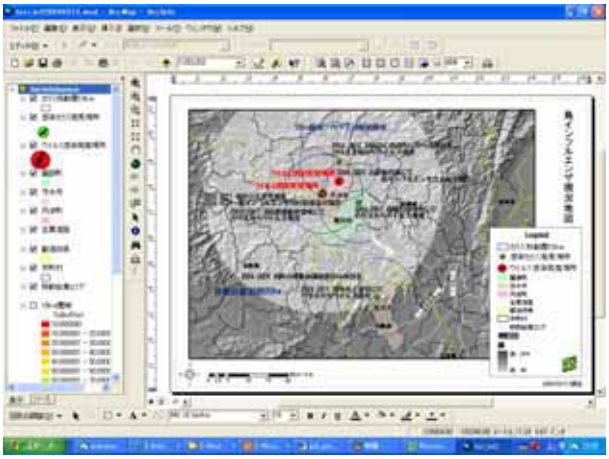

Fig.9: Template for Situation Summary

6. Conclusion

It is obvious efficient that local government use GIS as powerful tool of crisis response and management. Due to implement CombatGIS, local government should build Enterprise GIS as information infrastructure. But it is difficult that many local governments build Enterprise GIS and use it. So we need to support crisis response and management by establish Emergency Data Making Consortium composed of university, private company.

It is crucial that staffs of local governments attend the process deeply to build an Enterprise GIS and I have efforts collaborate with local governments and police department in neighborhood, I keep going my efforts to come true Combat GIS in our society.

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マルチハザード社会の安全・安心を守るためのGISの活用方策
－Enterprise GISを基盤としたCombat GIS－

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要旨

本研究は，いかなる危機的状況においても，自治体が，効果的な危機管理対応を図るための GIS を基盤とした危機管理システム構築を目指したものである．危機的状況が発生した場所で GIS を基盤とし様々な危機対応を支援することを Combat GIS と位置づけ， GIS を活用できる情報基盤を Enterprise GIS とした．本研究は，米国の先駆的な事例を調査し，日本の自治体における GIS の活用状況も把握し，日本社会に適した実践的な GIS の活用方策を提示したものである．

キーワード危機管理システム, GIS, Combat GIS, Enterprise GIS

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マルチハザード社会の安全・安心を守るためのGISの活用方策
ーEnterprise GISを基盤としたCombat GISー

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１．はじめに

1995年に発生した阪神・淡路大震災を契機とし、地理情報システム（GIS）は防災対策システムの基盤となるソフトウエアであるとの認識が高まり、多くの自治体の災害対策部門においてGISを利用した防災システムが導入された経緯を持つ。これらの防災システムは地震動予測・建物倒壊予測・洪水氾濫予測等自然災害発生にともなう、被害の絶対量を想定する被害想定システムが主流である。同時に、GISは国家的な政策のもの、空間基盤データの整備、庁内業務の効率化の向上、行政サービスの向上、現在では地域の活性化の目的で自治体はGISを導入している。阪神・淡路大震災を契機とし、GISに関わる2つの大きな取り組みがすすめられているが、前者は災害対策の部局、後者は各部局の業務支援システムというように、庁内でGISを利用する方法や形態が必ずしも連動していないのが現状である。本研究では、いかなる危機的状況においても、危機対応の主体である自治体が、効果的な危機管理対応を図るためのGISを基盤とした包括的な危機管理システムを提案し、住民の安全・安心を守ることに寄与することを目的とする。その際、時間的推移にともなう状況の変化をデータベース化、可視化、共有化できる等優れた機能を有するGISを活用することが効果的であると考え、その実践的な活用方策を提案するものである。

２．Combat GIS と Enterprise GIS

本研究では、自治体の危機対応に着目し、GISを基盤とした包括的な危機管理システムをCombat GIS（GIS　on the Site）と位置づける。すなわちCombat GISとは、自然災害、人的災害等人間の社会生活に混乱や大きな影響を及ぼす危機的な状況が発生した際、危機が発生した場所（自然災害では被災地）において、GISを基盤とし緊急対応、情報配信等様々な危機対応を支援できる情報基盤、緊急対応支援ツール等を含む包括的な仕組みである。つまり、Combat GISとは、”いつ”、”どこで”、”どのような” 危機が発生したとしても、現場においてGISを活用し危機対応を支援することを目指すものである。

Combat GISを実現するためにはデータ、データベースや運用体制等のGISを核とした情報基盤構築が必要であり、自治体のGISを核とした一元化（統合化）された情報基盤をEnterprise GISと位置づけた。

３．Combat GIS と Enterprise GIS に関する実践的な取り組み

米国ではGISを効果的に利用するための取り組みが積極的に進められており、危機対応におけるGISの活用の成功事例と報告されている。2001年米国・ニューヨークのワールドトレードセンター（WTC）の同時多発テロ事件と2003年南カリフォルニアで発生した大規模森林火災の2事例における危機対応へのGISの活用を調査し、災害対応におけるGISを活用するための着眼点を整理した。次に、Combat GISの構成要素や機能等を定義づけるとともにCombat GISを実現するための統合的な情報基盤となるEnterprise GISとの関連性を考察した。また、Enterprise GIS構築のために、現状の日本の統合的なGISの活用状況（日本における先駆的な自治体の活用状況）をヒアリングによって明らかにし、これら自治体の成功例、失敗例を整理するとともに日本社会におけるEnterprise GIS構築の方策を検討した。

最後に、本研究のケーススタディーとして京都府宇治市をフィールドとし、Enterprise GIS構築に向けた実践的なプロセス示すとともに平成15年12月18日に宇治市の小学校に不審者が乱入し、児童に傷害を与えた事件において迅速に双方向の情報共有システムを開発した事例と平成16年2月下旬に京都府丹波町の畜産農家において、鳥インフルエンザ感染した危機に対して地図を利用し時事刻々と変化する状況を整理・更新した事例を通してCombat GISの実践的な取り組みを示し、社会の安全・安心を守るための総合的なGISの活用方策を提示した。