

HKSAR Geospatial Information Hub (GIH) - A Common Geospatial Information Platform and Spatial Data Portal

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Key words: web-based GIS, GIH, geospatial data, spatial data sharing, integration, collaboration, GIS

SUMMARY

Geospatial information is essential to support social and economic development. Hong Kong, as a densely populated and highly sophisticated city, requires readily available geospatial information to facilitate effective government administration. To address geospatial data sharing and accessibility issues, a common geospatial information platform called the “HKSAR Geospatial Information Hub (GIH)” is developed in Hong Kong. The GIH is a web-based GIS platform developed by the Land Information Centre, Survey and Mapping Office, Lands Department, Hong Kong, China. The objective of the GIH is data sharing and convenient access to geographic information. It was formally launched in 2004 in the Lands Department and is continuously evolving ever since. The scope of implementation has already expanded to cover over 50 government departments and planning is underway to offer the GIH service for public access in the near future. Isolated and scattered geographic data from different sources are continuously being converted, integrated and distributed through the GIH through the government intranet. Since its implementation, more and more officers in the government can rapidly access mapping information, aerial photos, land status information, public facility information, ortho-rectified aerial photos, building and address information, countryside information, zoning boundaries, population census data, road and transportation facility information, geodetic survey information, etc. through the GIH. The GIH is more than a stand-alone GIS operated by GIS practitioners. It is a user-friendly common platform where different government departments forged partnership to share and disseminate specific geo-referenced attribute information and to access various geospatial information in a convenient way. This paper will elaborate the background, development, functions, implementation and benefits of the GIH. The implementation of the GIH reflects both vision and commitment in supporting a joined-up government for improved delivery of public service. It is a successful example on how the government can provide more efficient and better quality services to serve and protect the well-being of the citizen of Hong Kong by adopting geospatial information technologies and most importantly through collaboration.

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1. INTRODUCTION

Hong Kong is one of the most densely populated cities in the world. Its social service, infrastructure development, financial service, trade, tourism and logistic industries highly depend on the effective running of the government. Similar to large corporations, one of the key elements underpinning effective governance is information flow and availability. In the last decade, the government of Hong Kong Special Administrative Region (HKSAR) has encouraged bureaus and departments to embrace digital technologies. Despite gradually more adoption and increase in the use of geographical information system (GIS) technologies in both public and private sectors, the advancement in technologies do not necessarily result in increased geospatial data accessibility. Furthermore, due to complexity of geographic data, the systematic and scientific use of it generally lacks behind other kinds of data. This paper will discuss a successful implementation in Hong Kong where geospatial information sharing and access is greatly improved through a web-based GIS common geospatial information platform.

2. BACKGROUND

With the advancement in technologies, availability of digital data and the effort of professionals in various fields, geographic data becomes more widely adopted in the conduct of business and operation in the government. For those departments who have embraced GIS, GIS software on standalone computers is still the majority because of relatively simple implementation. Many of these GIS are usually designed to solve specific problems. The GIS creates and stores geographic data in different data formats under different data structures. Many of these GIS only have limited user base in each organization. From a broader perspective, information “islands” thus created.

Although information technologies have been introduced to the workplace in one way or another, the above phenomenon is not the ultimate objective of e-government. Dispersed geographic data increase the time and effort needed to find, obtain and compile the data and thus affect decision process. The duplicated resources needed in the studying and integrating geographic data is far from satisfactory. The isolation of data is also non-conducive to rapid response needed under crisis situation.

3. PROPOSED COMMON GEOSPATIAL INFORMATION PLATFORM

The situation as described above is not entirely satisfactory. On the foundation of three key concepts: integration, collaboration and sharing, a new GIS implementation approach was

proposed. It aims at improving the geospatial data accessibility issues with the following objectives:

- elevate from digital topographic mapping to geospatial data integration;
- implement a cross-departments, cross-stratum common geospatial information platform;
- promote geospatial data sharing; and
- improve geospatial data accessibility.

To realize these objectives, it is necessary to design and develop a GIS platform which allows easy access to geospatial data. In 2002, the Land Information Centre of the Lands Department (LandsD) began a new GIS initiative in LandsD and subsequently in the whole Hong Kong SAR government called “HKSAR Geospatial Information Hub (GIH)”. The GIH is a geospatial data sharing platform. It is a government-to-government (G2G) electronic service. Its main foci are to promote horizontal integration, cross-organization cooperation, improve efficiency and most important of all, improve the level of service to the public.

4. SYSTEM ARCHITECTURE AND DESIGN

The GIH adopts Internet, web-based GIS and database technologies. It rides on the Government intranet (GNET). It is designed to cross functional boundaries and to reach users across different domains. In the backend, the GIH adopts a three-tier software architecture with the presentation tier, application tier and data tier. This design enables effective management of different key components of the geospatial information service and provides flexible scalability. Each tier takes up specific tasks where the user interface, functional process logic, data storage and data access are developed and maintained as independent modules on separate platforms.

The GIH is created with extensive customization and code development using Java, GIS and database technologies. A Java Server Page (JSP) Model 1 architecture consists of a web browser directly accessing web-tier JSP pages was adopted in the original design. This allows mixing of regular, static HTML with dynamically-generated HTML and also provides access to database through the JSP Servlet Engine. The application servers process the dynamic contents where the digital map images are generated using web mapping server side software. The relational database management system (RDBMS) and a spatial database engine are used to manage and respond to query of spatial and non-spatial data. To support as many users as possible, a thin client approach is adopted where only an HTML browser is needed to use the GIH service.

In designing a large scale common geospatial information platform like the GIH, simultaneous access to graphics and non-graphics data as well as processing of computational intensive tasks have to be considered. To improve performance and availability, a load balancing cluster consists of multiple stand-alone servers acting in parallel across a local high speed network is designed to provide the geospatial information service through the GIH. Since mid-2006, the GIH is undergoing a major revamping with an aim to gain optimal separation of presentation from content by using the JSP Model 2 architecture. This model

can be seen as a server-side implementation of the popular Model-View-Controller (MVC) design pattern. (Seshadri, 1999) The benefit of this approach is in the cleanest separation of presentation from content, leading to clear delineation of the roles and responsibilities of the developers and page designers as the GIH becomes a more complex platform.

5. SPATIAL DATA

The GIH builds on multi-scale intelligent digital maps and ortho-rectified aerial photographs covering the whole territory of Hong Kong. It contains vast amount of data from LandsD and data provided by more than 10 government departments. There are about 40 major types of data grouped into 12 main categories including: Land, Emergency, Slope, Government, Health, Air-photo, Population, Education, Community, Housing/building, Transportation and regional, etc. The data owners provide graphics, textual attribute data or both in various forms for data integration by the LandsD. Although the GIH is a new architecture, much of its sources data come either from legacy GIS, CAD systems or simply databases. Heterogeneous platforms are involved. Therefore, the data conversion and uploading is far from straightforward. The issue is particularly troublesome when data of different formats, different structures, different qualities and data with annotations have to be tackled. To address these issues, many data conversion and loading modules have been designed and developed.

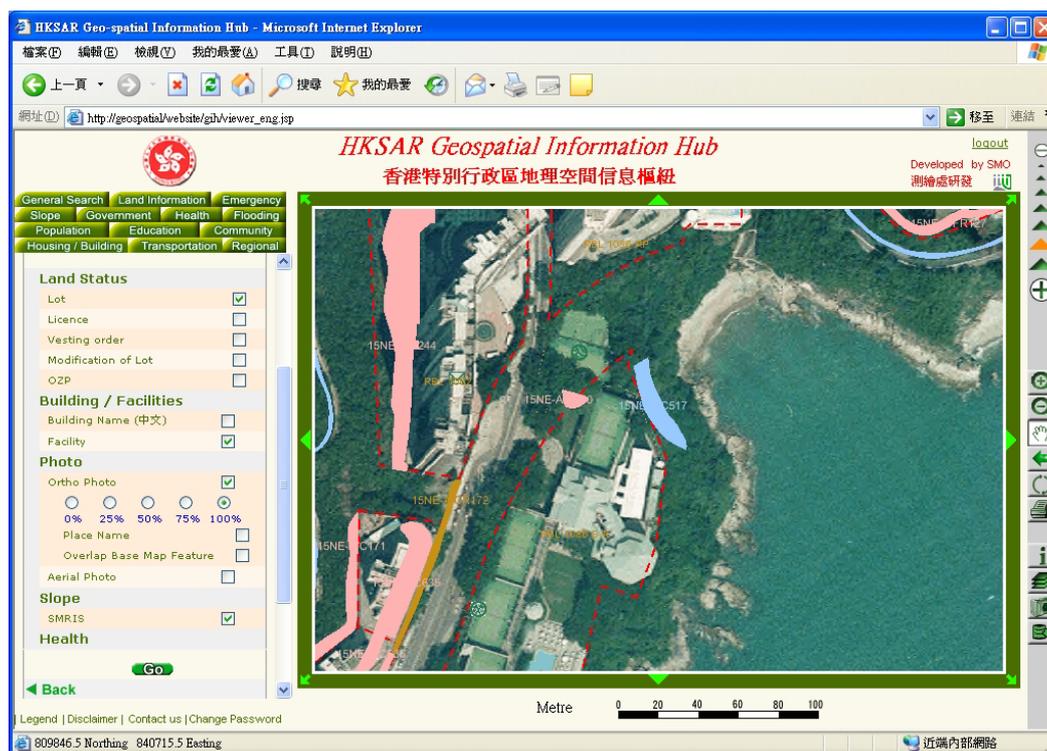


Figure 1: Geospatial data from different sources integrated into the GIH

The GIH offers over a hundred kinds of spatial features and related attributes. GIS specialists in LandsD systematically integrate and organize land, building, statistics, transport, health and

environmental related data into a common datum. Some of the data processing works are done regularly while some are done in an ad-hoc basis. The frequency of data updates vary from near real-time to weekly or annually.

| Type of Geospatial Data | Number of Features in GIH |
|-----------------------------------|---------------------------|
| Building Polygons | > 190,000 |
| Lots (Land Parcel) | > 340,000 |
| Roads/Streets | > 4,000 |
| Aerial Photographs | > 190,000 |
| Old and Valuable Trees | > 500 |
| Historical Buildings or Monuments | > 1,000 |
| Recreational and Sport Facilities | > 4,000 |
| Educational Institutions | > 3,000 |
| Community Facilities | > 10,000 |
| Transportation-related Facilities | > 5,000 |

Table 1: Statistics of major types of geospatial data in the GIH

6. MULTI-PURPOSE COMMON GEOSPATIAL INFORMATION PLATFORM

Through the Government's internal network (GNET), the GIH is capable of dynamically delivering high quality maps, aerial photos and various types of geospatial data in textual format to officers in the government supporting their daily operation. Apart from search and display functions, the GIH provides capability for users to download, print and perform analysis. Since its implementation, officers in different divisions of Lands Department can rapidly access aerial photos, land status information, public facility information, block government lease images, ortho-rectified aerial photos, building and address information, zoning boundaries, population census data, road and transportation facility information, geodetic survey information, etc. through the GIH. It greatly enhances the efficiency of different operations.

6.1 Application in Survey and Mapping

One of the major application areas of the GIH is to support mapping and land administration. In LandsD where the GIH service originated, officers in the Survey and Mapping Office (SMO) can use the GIH to search for and to locate the subject sites being surveyed. Moreover, land status information and geodetic survey control information can also be obtained from GIH. In the creation of 3D digital city models, officers in LandsD can make use of the GIH to understand the building top conditions, to obtain building information such as addresses, number of storey and geo-reference numbers.

6.2 Application in Land Administration

Land administration plays a dominant part in the economic and social development of Hong Kong. The Land Administration Office (LAO) of Lands Department is a major group of users of the GIH. The LAO is responsible for the disposal of government land. It acquires private land and clears land required for public works projects. It is also responsible for managing government land to ensure that it is not illegally occupied. The LAO also performs squatter control and clearance duties, processes small house applications and undertake preparatory work on resumption and clearance of land. With the GIH, officers in LAO can search and view the location of a proposal through their desktop computers. Users can also obtain land status and zoning information of the subject and adjoining sites. In lease enforcement operations, officers can study the aerial photos showing the buildings and constructions on a particular site. The GIH also facilitates the slope maintenance activities where case officers can understand the geographic conditions, the as-built features as well as the land parcel information of the subject area. Officers in LAO can also use the GIH to search and locate specific types of buildings by using the GIH. They can also make use of the aerial photos in the GIH to identify the as-built condition of a specific site, e.g. assist in identifying possible illegal structures.



Figure 2: GIH incorporating information of old and valuable trees

6.3 Application in Public Health Management

One of the very successful examples of the application of GIH is the collaboration between Lands Department and Food, Environmental and Hygiene Department. Recognizing the usefulness of the GIH and GIS expertise in Lands Department, the Food, Environment, and Hygiene Department forged partnership with Lands Department to expand the capability and contents of the GIH with an aim to better support the monitoring and control the spread of dengue fever in Hong Kong. The GIH proves to be a meaningful initiative which has facilitated more effective government service. To facilitate the monitoring and control of the spread of dengue fever in Hong Kong, the location of ovitraps in 38 surveyed districts of Hong Kong and ovitrap associated attributes are integrated into the GIH on a regular basis. Advanced functions, including spatial analysis and trend display functions, were developed by Lands Departments to facilitate efficient visualization and retrieval of summary by officers in Food, Environmental and Hygiene Department as well as those in other government departments. The improved availability of vital information helps expediting follow up actions by frontline officers. With GIS analyzed results, the respond operations can also be more specific. This is a good example of cross department partnership and adoption of geospatial technologies for the delivery of better public service.

6.4 Application in Diversified Disciplines

The GIH as a common geospatial information platform has a wide area of application. The GIH can deliver the following geospatial information service:

- To provide a means of journey and operation planning for outdoor works.
- To provide geodetic survey information to surveying staff in LandsD and survey division in other engineering offices.
- To allow officers in various departments to identify the locations, details and maintenance responsibility of the registered slopes.
- To present electoral boundary plans and to support the election of Village Representatives and the consultation process.
- To visualize demographic, census and population data that are useful in town planning, infrastructure development and emergency situations.
- To facilitate the search and rescue operations of the disciplinary force
- To provide aerial photographs taken from 1924 to current to facilitate users to trace the change of the development, the existing development and landscape of any area.
- To provide a convenient way for users to obtain point-to-point distance through and also to estimate the approximate size of site with simple geometry.
- To facilitate operation planning and site understanding by viewing the 3D models of a selected area.
- To facilitate the efficient handling of village improvement requests with ready availability of land status information.
- To facilitate GPS usage of outdoor users through the provision of transformation and display functions.

- To support environment conservation and sustainable development by providing integrated habitat mapping data.
- To provide integrated land and geographic information to government departments for various decision making processes and operations.

7. BENEFITS OF THE COMMON GEOSPATIAL INFORMATION PLATFORM

The GIH is a simple and easy to use geospatial information service. It is also a common geospatial information platform which improves availability and accessibility of geospatial information within the Hong Kong SAR Government. With this new GIH service, Government officers can find, download and print maps, plans, tables, graphs and photographs at their desktop computers. In addition, real time spatial analysis functions are also provided through the GIH. Most important, officers can now visualize the physical condition or understand the location pattern of different real world features right at their fingertips. The benefit of the GIH is its ability to fully exploit the usefulness of existing government data. It improves overall operation efficiency and government's ability to respond in urgency situation. It also helps to reduce the total cost of data ownership within the government because it reduces duplicated resource needed in data acquisition, processing and building similar computer systems.

The major benefit of a common platform like the GIH is that it attempts to take apart invisible boundaries between institutions. It realizes the concept of a joined-up government by gathering various kinds of geospatial information otherwise locked up in individual data silos. It facilitates information sharing within the Government. More importantly, it enables better and more effective public services. The benefits of GIH include:

- Empower government officers with geospatial information
- Provide a platform for convenient and immediate access to geospatial information
- Provide a common geospatial information platform for information sharing within the government
- Improve availability and accessibility of geospatial information
- Reduce turnaround time of daily works
- Enhance efficiency thus increase productivity
- Enable better informed decision
- Reduce duplication of effort in data integration
- Reduce duplication of investment in building similar computer systems or GIS individually
- Facilitate the preservation of old and valuable trees.
- Eliminate system development and implementation effort at user-end
- Support swift action and decision making in crisis.

8. DISCUSSIONS

This GIH initiative can be viewed as a business process re-engineering within the Government. It empowers government employees with geospatial information, improve

information distribution and streamline operations. This new service also gives users "integrated" information. With information from multiple sources integrated into a single unified nature, new pattern or phenomenon can be revealed more readily. Decision makers can get better insight into the situation which they could never or easily do before.

The challenge in developing the GIH is not simply on the technological aspect, but also on cultural aspect. The development and implementation of the GIH is an endeavour to change institutional culture within the government most notably on data sharing and collaboration. Some data owners in individual departments, who might be sceptical in sharing data in the past, are more willing to share their data for integration to the GIH after seeing the benefits of the common geospatial information platform which can reduce development costs, development time and subsequent data updating effort.

The GIH, as a common geospatial information platform, has indeed a much wider scope of application than simply supporting mapping and land administration. It is a platform with interdisciplinary participation supporting multiple purposes. Since its introduction in 2004, it has been gradually introduced from 20 departments to more than 50 bureaus and departments. These institutions have distinct functional roles with officers specialized in different fields, capitalize on the readily available information in the platform.

The existence of GIH in the government has also provided an opportunity for IT managers and users in different departments to consider different options available in embracing GIS technologies. In the past, the most obvious option is the acquisition of standalone GIS software, developing GIS in-house or managing an outsourced GIS development and implementation project. All these approaches require either personnel proficient in GIS to lead or personnel with strong management experience to implement the GIS. Most importantly, project owners also need to spend significant effort in system design, data capture and data processing. It is a time and resource consuming process which is not the core business of many departments. However, with the availability of this common geospatial information platform with large amount of integrated data, a new option is in front of IT managers and decision makers. With this option, GIS development and management, data integration and system design and testing can be led by professionals in the field of GIS, mapping and information technologies. Users in different departments can focus more on their core business instead of diverting their precious resources into developing GIS tools to support their works. This collaborative approach is a "win-win" situation within the government and also a clearing advantage for the public.

There are some progress in sharing several specific types of geospatial data within the government under the Data Alignment Measures (DAM) initiative started in 2003. Despite this advancement, comprehensive Spatial Data Infrastructure (SDI) policy does not exist in Hong Kong. This is a contrast as compared with many advanced nations and developing countries in the world. Under this circumstance, data can be in the form of GIS data, CAD drawings, textual databases, spreadsheet tables or even paper drawings or listing on papers. Data sharing are voluntary while data updating frequency and data formats vary considerable. The diversity of the formats and structures of the source data create significant problems in

data consolidation and integration. It is also a time consuming task to develop necessary data conversion computer programs fitting each kind of data, with varying data quality. While some types of data are exchanged and updated regularly, some types of data have to be requested every time. For efficient sharing of geospatial data in Hong Kong, there is a compelling need for the government to take the lead in coordinating the formulation of a comprehensive SDI policy in Hong Kong. This is a strategic and important step in public service if Hong Kong is to realize a seamless join-up government with highly effective and efficient data sharing across institutions.

The development and implementation of the GIH is not a small initiative that simply satisfies Lands Department's internal operational needs or the needs of FEHD in fighting dengue fever. The work has surpassed these goals and has a deeper meaning. The GIH can be seen as a valuable foundation for the Hong Kong government to increase the adoption and utilization of geospatial information for better public service. Preparation is underway to modify the GIH and interface it with the government's one-stop access portal, GovHK, with a view to providing a user-friendly web-based common geospatial information platform for public access. This is a logic step in providing citizen centric e-government service for the general public.

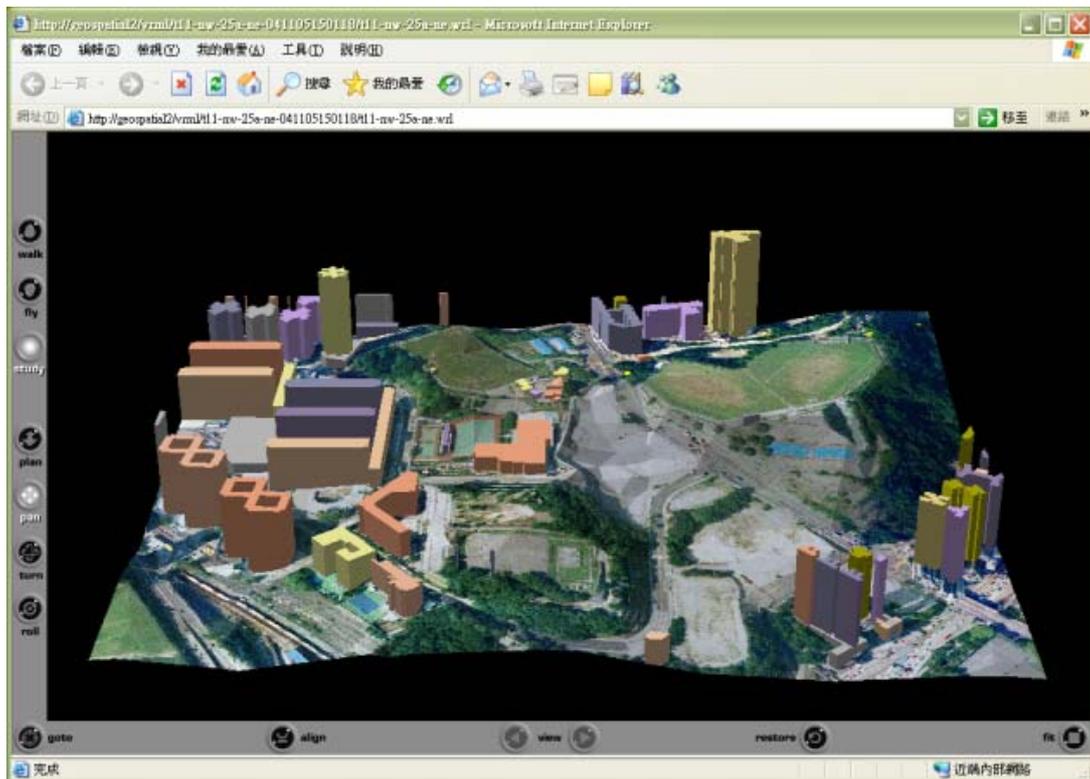


Fig 3: 3-dimensional landscape function in the GIH

9. CONCLUSION

Rapid advances in information technology has come an abundance of data that is overwhelming and cannot be processed efficiently by humans alone. (Hammer, 1993) The GIH provides an environment not only for displaying geographic data but also allows for the sharing and exchange of information among autonomous heterogeneous computer systems which are owned and controlled by different entities.

Over the last ten years, various offices and government departments have implemented project-based GIS serving the departments' specific internal needs. If not impossible, it is most difficult and time consuming to obtain and consolidate the required data when needed. Much attributed to the fact that the data are scattering in different locations, stored in different data formats with different data structures under the control of different departments and offices. Although some software vendors have been actively promoting GIS as turnkey systems, many departmental level GIS that were built in the last decade were sophisticated systems which were basically operated by a handful of frontline staff who understands the intricate operating procedures and underlying GIS theories. The GIH was being designed and developed to address these issues. It is a one-stop geospatial information portal which aims at improving accessibility of geospatial information in the whole government.

The GIH integrates vast amount of geospatial data that relate to social and economical development of Hong Kong. It is an enormously informative web platform containing millions of geospatial features and attribute data. In Lands Department, the GIH has been implemented in over 30 offices: District Survey Offices, District Land Offices, Geodetic Section, Slope Maintenance Responsibility Information System Unit, Photogrammetric and Air Survey Section, the Technical Information Section, etc. Land administration and surveying users are very satisfied with the overall efficiency gain in geospatial information search and retrieval. Externally, the GIH supports the operation of more than 50 government bureaus and departments, including: the Housing, Planning and Lands Bureau, Chief Secretary for Administration's Office, Food and Environmental Hygiene Department, Government Flying Services, Home Affairs Department, Department of Health, Registration and Electoral Office, Agriculture, Fisheries and Conservation Department; Planning Department; Buildings Department; Hong Kong Police Force; Hong Kong Observatory; etc.

The underlying principle behind the GIH is more efficient access and sharing of geospatial information. It enables government officials to access different kinds of work-related geospatial information within the reach of their fingertips instantaneously. The instantaneous nature of GIH provides a dramatic improvement in information flow and also helps to move projects faster. It relieves government officers from time consuming manual search and thus reduces turnaround time of jobs and thus improves service delivery. From technical and resource perspective, this new service eliminates duplicated data conversion, manual fitting, scaling and overlaying of different forms of geographic data in paper form. With information from multiple sources integrated into a single unified nature, new pattern or phenomenon can be revealed. Decision makers can get better insight into situations which they could never or easily do before. The implementation of GIH reflects both vision and commitment in

supporting a joined-up government for improved delivery of public service. It is a successful example on how the government can provide more efficient and better quality services to serve and protect the well-being of the citizen of Hong Kong by adopting geospatial information technologies and most importantly through collaboration.

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