Visualizing Land Reclamation in Hong Kong: A Web Application

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Abstract.
Hong Kong's natural terrain is extremely hilly and developable land is scarce. In order for it to become a metropolitan city that it is today, numerous land reclamation projects were carried out to create buildable land. It is estimated over 35% of its developed land area has been reclaimed from the sea [1]. These reclamation projects significantly altered the coastline and buried important heritage artifacts. Although there are reference texts and books written for this subject, and most visualizations found are not comprehensive and only focus on one area at a time. The most recent official paper map of reclamation authored by Hong Kong Lands Department is dated 1996. Therefore, a tool for visualizing spatial and temporal datasets of HK land reclamation is needed to give the full picture of the evolution of the Hong Kong coastline. This paper presents Hong Kong Coastline Web Map - an interactive map application that utilizes spatial temporal data for understanding the location and extent of each reclamation project, as well as related historic photographs that reveal the forgotten stories of the city's changing coastline.

Hong Kong Coastline Web Map: http://www.oldhkphoto.com/coast/

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1. Introduction

Most of the skyscrapers that make up the iconic Hong Kong skyline we see today are built on reclaimed land. *Figure 1* shows the changes to the coastline in 50 years, from dockland to the wide boulevard. Natural features in the original coastlines such as coastal islands, wetland and beaches are buried

and erased to make way for progress. Together with demolished manmade structures such as historic ports, military barracks, docks, and significant buildings, they record the story of Hong coastal development from a fishing village to a metropolis over the span of 150 years. The presentation of such information so far has been limited to prints, such as books and 2-D maps. While they present useful information of the physical boundaries of reclaimed land and historical facts, the information quickly becomes out of date as new reclamation projects are carried out. This paper presents Hong Kong Coastline Web Map as an interactive, updatable map application that overlays historical context with the temporal and spatial information to give a holistic overlook at Hong Kong's coastline transformation through the means of land reclamation.

Figure 1. Comparison of Hong Kong Coastline at Wanchai from 1960 to 2012. (www.hkoldphoto.com).

For the past year, the author have been conducting research on the topic of land reclamation with a group of volunteers called Map-Reading Group based in Hong Kong. The group gathered historic maps, photos and news articles on the object from various sources [2, 3, 4, 5] to examine the changing coastline of Hong Kong since British Colonization. The findings were later published in the book called "Coastline of Hong Kong" [6]. Graphic maps such as the one shown in *Figure 2* were produced for the book to illustrate the location and the extent of reclaimed land and landmarks.

Although the book is very informative, the current coastline illustrated in the graphic map will be of date soon as multiple land reclamation projects are currently being carried out. The text, photos and map are also displayed page by page; one would have to flip pages back and forth to refer to landmarks mentioned in the text with the graphic map, which is difficult for the user to navigate through time and space. Therefore, there needs to be a live, and interactive web application that can display map with texts and photos overlays and allow geospatial data to update easily. Through the Hong Kong Coastline

Web Map, users can visualize the location and the progression of land reclamation through time, with interactive pop-up windows that provide information such as name, descriptions and year reclaimed of the plot. The interactive time slider allows users to see the progression of these projects, as well as to isolate reclamation projects in a certain time period. Geo-tagged historic photos are overlaid to provide context.
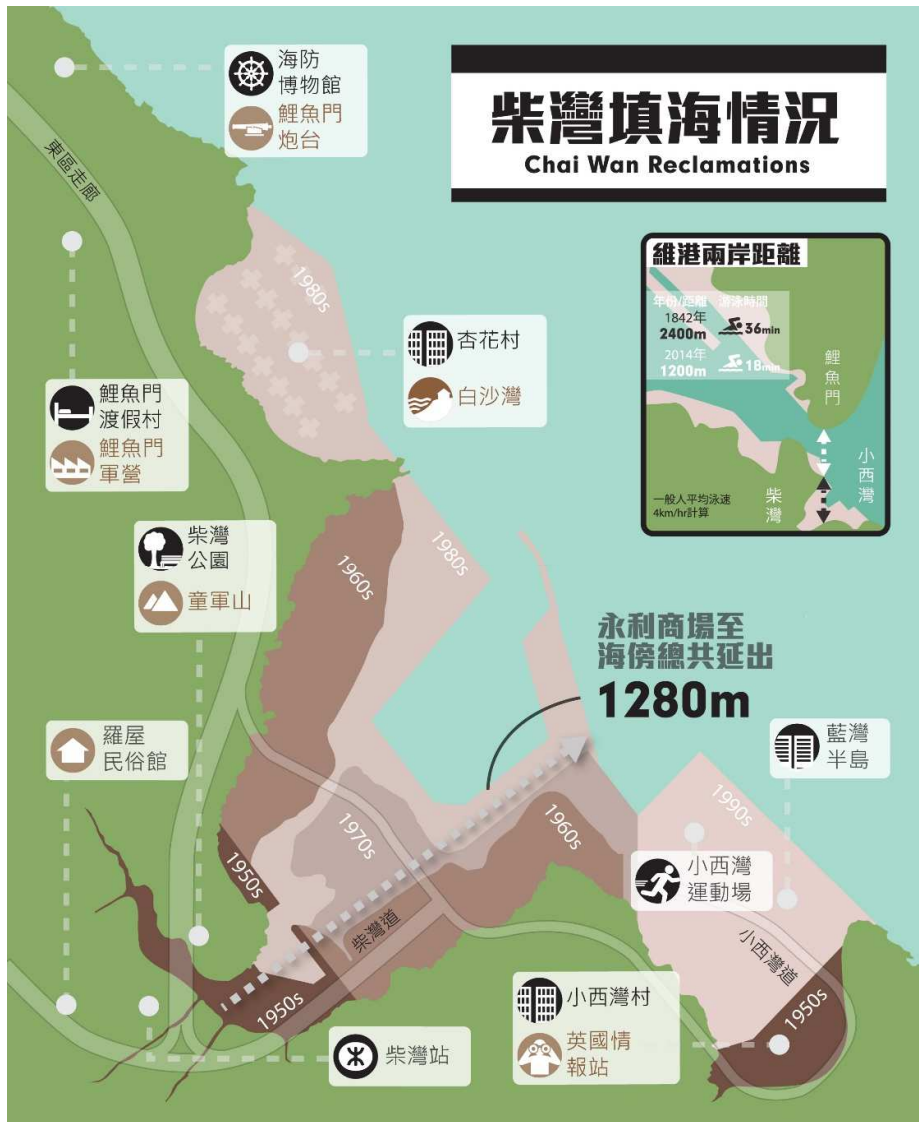

Figure 2. Graphic Map featured in the book "Coastline of Hong Kong"

Currently, the coverage area for this web map application is Hong Kong Island, with the intent to expand to Kowloon, New Territories, and remote islands in the next phase. *Figure 3* illustrates the current coverage area.

Figure 3. Web Map coverage area currently on Hong Kong Island only.

2.   Data Preparation

Based on the graphic map produced for the book "Coastline of Hong Kong", spatial data, such as the original natural coastline and reclaimed boundary, were digitized using Google Maps Engine[1] and export as KML files into CartoDB[2] for customization. Lastly, JavaScript and CSS libraries were used to add interactivity to the web app in the API environment. *Figure 4* illustrates the steps from to create spatial data from graphic map to web map.
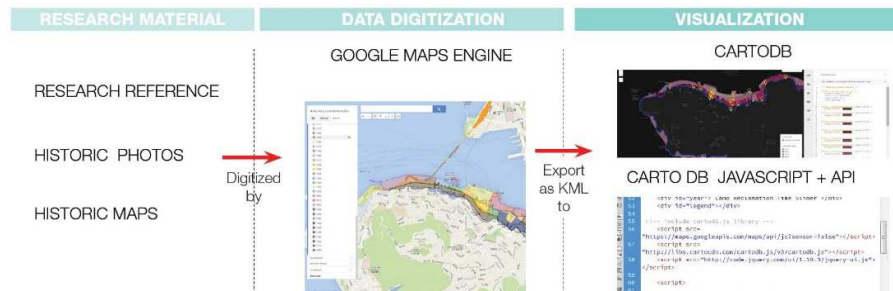

Figure 4. Digitization process.

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[1] https://mapsengine.google.com

[2] http://cartodb.com/

2.1. Data Source

The three layers that make up this web map application are Hong Kong Original Coastline, Reclaimed Land, and Historic Photos. *Table 1* is a summary of the data used in this application.

Data Name	Source	Contents	How was it prepared	Additional Data
Hong Kong Original Coastline (pre 1840) - Line Feature	I digitized the dataset based on historic maps owned by Hong Kong Public Library [3], University of Hong Kong [4], and Hong Kong Government [5].	The 9 line features in this dataset together make up the entire original coastline of Hong Kong Island. These lines are categorized by the location of the Island, i.e. Southern Coastline	I digitized it in Google Maps Engine. I was not able to trace the map with overlays because the function isn't available in Map Engine. I did my best to refer to the historic maps based on street and natural location.	The current map shows only the Hong Kong Island reclamation projects. I hope to continue to research the original coastline for other parts of Hong Kong.
Reclaimed Land Polygon Feature	I digitized the dataset based on historic maps owned by Hong Kong Public Library [3], University of Hong Kong [4], and Hong Kong Government [5].	There are about 70 polygons categorized by the year they were reclaimed in this dataset. Info window with feature information pops up when feature is clicked.	I digitized it in Google Maps Engine. The automatic snapping tool really helped me to get accurate lines between each feature.	The current map shows only the Hong Kong Island reclamation projects. In the future, I hope to also add reclamation data in other parts of Hong Kong, such as Kowloon and the remote islands.
Historic Photos Point Feature	I digitized and geo-referenced photos from the website www.hkoldphoto.com [6].	These point features designated the location of relevant historic photos. These photos give us a glimpse what the city was like before and after each reclamation project.	I digitized the location in Google Maps Engine and used CartoDB's visualization function to link the image URL to the info window.	Currently, the points are not categorized, so I hope in the future they could be categorized by district. Buttons or drop down menu would be added and allow users to see certain photos based on where they were taken.

Table 1. Description of the data layers that make up the web map.

2.2. Data Digitization

The most challenging tasks in this project was to digitize the data: from illustrative graphic maps to spatial data, and therefore choosing the right software would be crucial for carrying out this task efficiently. The intuitive Google Map Engine and powerful visualization capability of CartoDB were found to be most suitable for production and visualizing data for this project. *Figure 5 and Figure 6* illustrates the Google Map Engine and CartoDB interface, respectively.
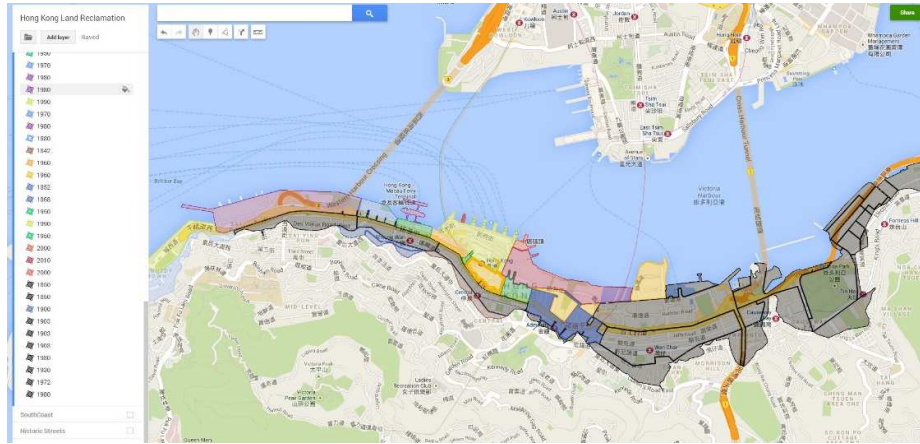
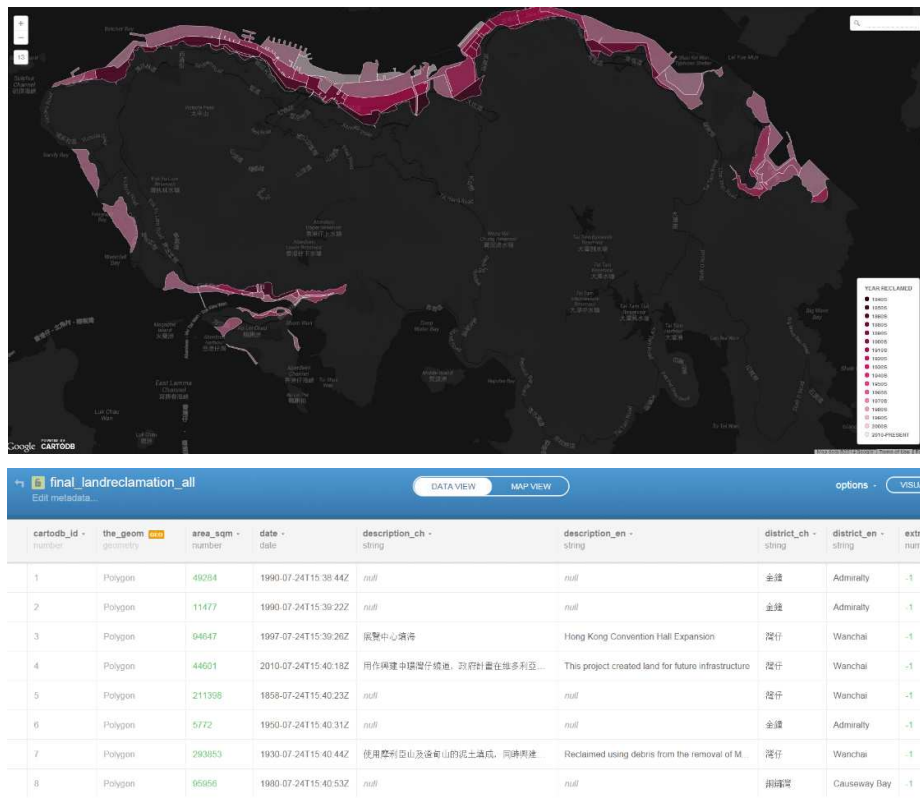**Figure 5.** Google Map Engine web interface.

Figure 6. CartoDB Data interface – map view (top) and data view (bottom).

3. Web Application Design

The design of the web application focused on its usability and clarity of the visualization. A clear title and descriptions indicate the topics being explored with this map. The web map application has standard components for good usability: zoom in/out toggle for navigation, sharable button for sharing the map through Facebook, twitter or embedded link, and full screen button for the map to fill the entire screen. Figure 7 shows the features of the Web Map.
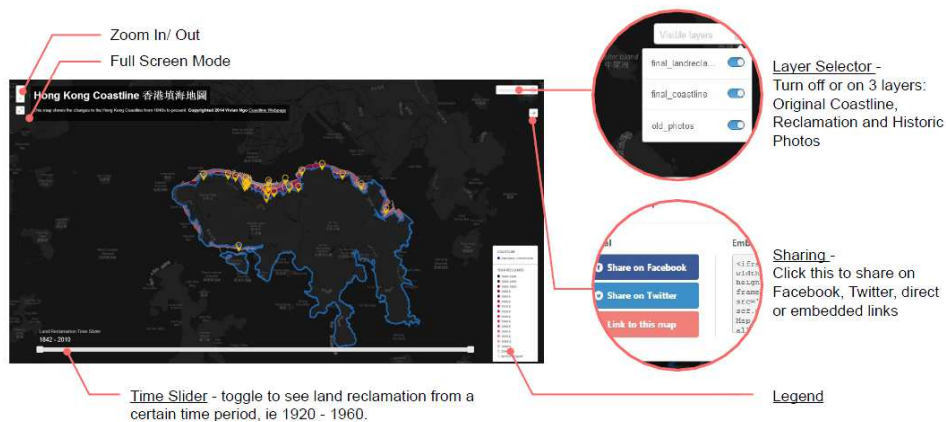

Figure 7. Hong Kong Coastline Web Map features.

For the base map of this application, a dark Google base map was chosen to create big visual contrast to the interactive layers, which are in shades of magenta. A layer selector is located at the upper right hand corner of the screen for users to turn on and off layers, which are the original coastline, relcaimed land, and historic photos, in case they want to see each topic seperatedly. A legend indicates the symbols for the features on the map: the blue line as the original coastline, and the extend of reclamation color-coded by year.

3.1. Land Reclamation Visualization

Using JavaScript with CartoDB API, a time slider was created to allow users to toggle and visualize land reclamation based on a period of time. *Figure 8* shows how the coastline has changed from 1933 to 1997 as users interact with the time slider. Besides the time slider, each feature in the land reclamation

layer when clicked and hover would trigger a pop-up info window with descriptions, names, district and year of the land reclamation project. Figure 9 shows the pop-up info window.
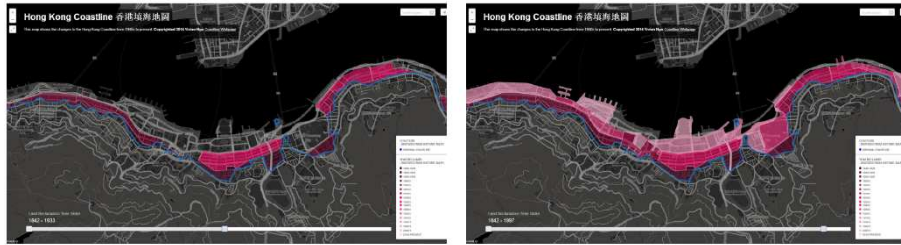

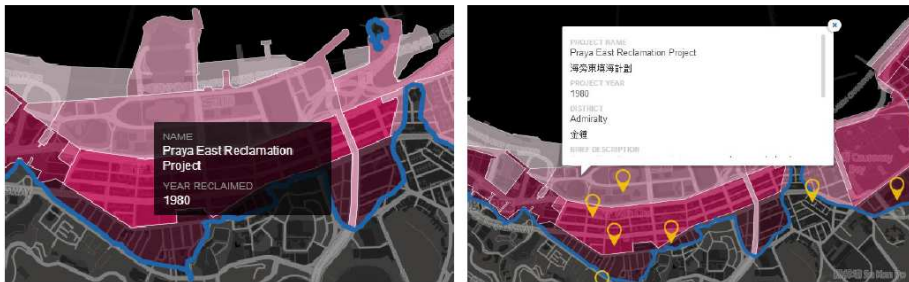**Figure 8.** Reclaimed area at 1933 (left) and at 1997(right)

Figure 9. Hover info window (left) and click pop-up window on land reclamation layer (right)

3.2. Historic Photo Layer

Historic photos depicting the historic context are indicated with the yellow pin symbol on the map. When the mouse hovers on a pin, an info window pops up to indicate the name of the photo. The hover window style for photos looks different than that of reclaimed land in order to avoid confusion. When the pins are clicked, a bigger pop-up window with historic photo header and descriptions appears. *Figure 10* shows the historic photo pop-up window.

Figure 7: Hover info window (left) and click pop-up window on Historic Photo Layer (Right)

4. Discussion and Future Work

This paper presented a web application, Hong Kong Coastline Web Map, that gives insights to the development of the city as lands are reclaimed from the sea, along with valuable historic photos that give glimpses of life in the past. Interactive features relating spatial and termporal data, such as the time slider and info window, give user a better sense of understanding of the changing coastline of Hong Kong. The next steps is to carry out this effort to other parts of the city such as the Kowloon Pennisula. The ultimate goal is to document and visuzlize the entire city's land reclamation history.

References

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