

Land information system for tourism and housing uses in patrimonial Valparaíso

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Abstract.

A project aimed to improve the management of these two items is being undertaken by the science faculty lab of the Universidad de Valparaíso. One of the involved goals was to produce high quality cartography standards to be used as platform for current and future applications related to housing and tourism fields. However, this study has also represented an opportunity to experiment other techniques for map presentation and visualisation, where an integrated group of cartographers, geographers and surveyors have interacted to achieve coherent results to the main objective fulfilment.

Introduction

The University of Valparaíso Science Faculty and associated organizations have been carrying out an extensive project since 2007, whose main aim is to provide of effective geographic tools to relevant society components (tourism regional service, construction association, commerce association) to strength their capabilities, and to improve benefits for the local community as well. This project has been economically supported by CORFO (a Chilean state division) having three years as maximum lasting (finishing at the end of 2009). Among the several goals comprised within this project, the basic land planning elements played a decisive role for the study development. Most of applications and observed interactions were narrowly related to territory, hence, an accurate cartographic base was required to transfer each thematic activity to a set of stable and long term documents. This paper highlights those aspects linked to the cartographic production as basis for the entire project development.

Accurate local cartography needs.

The complete study area covers 20.000 hectares (Figure 1) being this amount covered by urban spaces. For years, several partial surveys at different scales have been undertaken within the zone in order to satisfy urban planning and land administration instruments. These surveys have been usually required by government departments or private sectors. However, the alternative geodesic frameworks used, the different projected scales and also different data sources have contributed to deal with sets of non connected maps. Moreover, if non related to cartography or geodesy professional staff is encouraged to use and match this data, many positional mistakes can be easily occur. This fact led to territory users to manage alternative documents for urban planning, such as internet maps and high resolution satellite imagery, additionally to the previous tools. If high accuracy maps were required (including even engineering projects) with low positional error standards within a common geodesic system, a new integrated and wide survey was required. This was the first challenge that the staff faced, due to the high cost that the external service implied to produce such requirement.

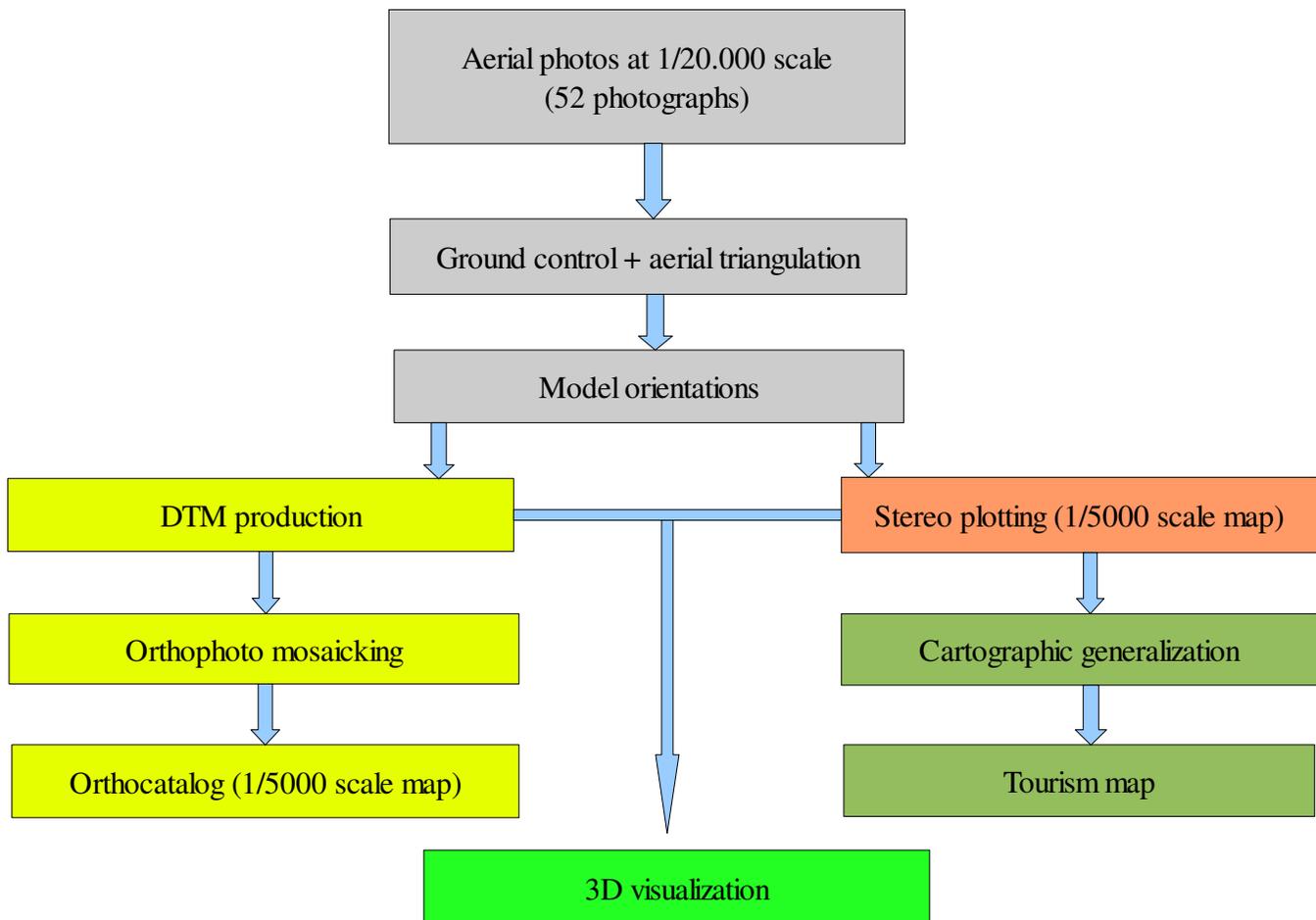
The cartographic and photogrammetric production process.

In order to produce accurate cartography as benchmark for land planning, engineering, land



Figure 1. Valparaíso – Viña zone

administration, tourism and other applications the complete available aerial coverage was purchased to undertake the aerial survey as first stage. The scope of the map production aims is presented through the flow diagram .



Colours here are referred to different objectives. While grey comprises the basic photogrammetric process (essential for the subsequent products) the yellow boxes point out towards the so called “unique base map” or the platform to fit other local maps. This is the case of orthophotos, stored as a catalogue of 40 sheets at 1/5000 scale. On the other hand, stereo plotting itself is a reduced area product aimed to be used under GIS platforms, which includes the standard information levels currently used in this type of aerial surveys.

The tourism map (dark green) involves the extraction and generalization of several information levels contained in the stereo plotting. The final scale of this map was 1:8000 for its publication in high accessed areas, such bus stations, bus stops and others, and also in private sectors as hotels and lodges. The light green involve an interactive 3D visualisation, where both touristic attractions and commercial sites can be visited (being developed). The view of these desired places will be performed through the website using the node designed by the technical staff.

The photogrammetric process

An amount of 52 metric colour aerial photographs at 1:20.000 scale covered the whole project area, at 1700 DPI resolution, involving a ground pixel size of 0,3 m. The adjustment for exterior orientation parameters calculation comprised an individual mean square error lower than 1 pixel per photograph. For such purpose, 30 control points were measured in the fieldwork stage, distributed as presented in figure 2. The selected bridging distance determined measurements each four models, and levelling chains at the same distance (actually, the obtained coordinates through the GPS were fully 3D).



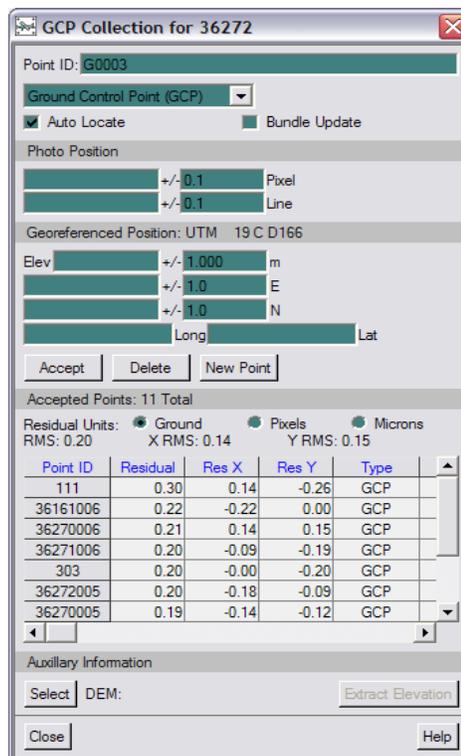
Figure 2. The north photogrammetric block coverage.

The Von Gruber tie point distribution was used in the aerial triangulation, due to its high reliability

when identifying singular artificial features, such as sidewalk corners, sinks, highway junctions and others. Automated selection procedure as tie point determination by matching means were not used

because an important natural elements existence in the zone (trees and bushes). A subsequent tie point selection and deletion (for points placed at non reliable positions) would have implied an additional time consuming task. Just in case were only open landscape areas were tackled for tie point location, reduced size elements such as rocks or low bushes were selected for this purpose. The quality of aerial triangulated points was empirically assessed by orientating some models, observing their resultant RMSEs, as presented in figure table 1. The overall standard deviation in Von Gruber pricked points within the three photo blocks did not exceed one pixel, assuring a rigorous orientation, and allowing to produce accurate DTMs (Figure 4) and stereo plottings by working in practise without Y parallax effect, which led to obtain a high standard orthophotomosaic and later vector maps.

Tables 1 . One absolute orientation example based on aerial triangulated points. RMSEs do not exceeded one pixel at photo scale (0,3 m)



Orthophotos

A subdivision from the general orthophotomosaic was performed in order to produce 70 x 50 cm regular sheets (3500 x 2500 m in ground units) embedded within a regular template, containing additional cartographic elements (Figure 5). Colour enhancement to reduce visible changes in transitional areas from one to other orthophotos was undertaken as well, to provide an homogeneous and attractive terrain view.

A metric assessment on the orthophotos was executed by measuring well defined points on the terrain

surface (using geodesic GPSs) and their correspondent orthophoto imagery coordinates. This task enabled to establish how accurate was the final product, yielding a quantity of 1.2 of meter circular error at 95% confidence level. This parameter enables to use the orthophoto set as the base map to be referred to by other maps at the same or minor scales within the region.

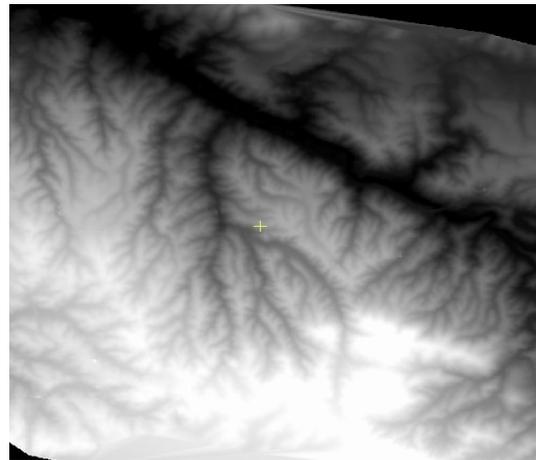


Figure 4. A dtm example obtained by means of matching, after the model orientations.



Figure 5. An Orthophotomap example (the whole set is composed by 40 sheets) at 1/5000 scale.

Touristic Map

The city of Valparaíso has been chosen by United Nations as humanity patrimony, requiring of good quality touristic information. The thematic availability of touristic maps aimed to provide the wider idea about places to go is one relevant aspect related to this. Lodging, distances to be walked, museums

or other attractions demand a permanent travel time evaluation form users. On this basis, several good experiences designed to satisfy this need can be counted on at present (including web maps) mainly undertaken by private companies. However, it was considered to create a mixture between topographic features (hill shading, contour lines) and cultural elements (blocks, lodging and touristic places) in this case to portray a crucial element usually not considered at the time of map production here, which is the topographic component. A computed distance between two points will probably be assumed as a flat distance in many other cities, but not in Valparaíso. The slope and height variables imply different time travelling specially if walkings are desired. Besides, the nature and condition of this important city can be comprehensively perceived through an innovative cartographic document which includes this information.

Other assumed goals when creating this map were related to facilitate lodging searches to a broad type of tourists, from low budget national or international visitors to those who could afford more economic resources. In that sense, the lodging kind aggregation was divided in: hotels, “boutique hotels”, lodges, bed and breakfast and houses. This list (Figure 6) was subsequently highlighted and coloured within the overall symbology, including the lodging address and a positional graticule to make any search easier. This graticule do not require geographic knowledge from users being simply focused in the most basic way to find positions in a map. Therefore, visitors who want to stay in a bed an breakfast once arrived to Valparaíso bus station for instance, can easily perceive lodge positions and distances related to the bus station, telephone numbers, addresses and so on

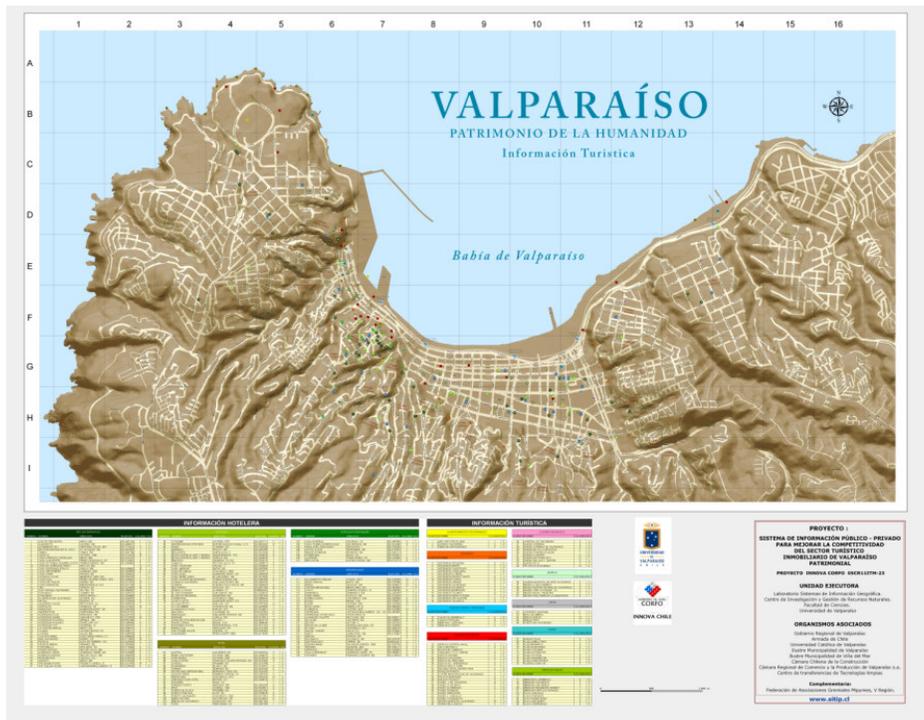


Figure 6. Valparaíso touristic map.

A third component was the most conventional touristic site locations, also symbolized by colours and classified according to their types (historical sites, museums, commercial zones). They were catalogued

within the location graticule system as the lodging item as well.



Figure 7. Different colours used to symbolize lodging and touristic attractions, plus the basic street network and relief presentation through coloured hill shading.

Stereo plotting

From the stereoscopic models a number of information levels were extracted to be structured in the form of regular sheets (3500 x 2500 m) to be used under GIS platforms. Buildings, blocks, green areas and conventional layers at 1:5000 aerial surveys were plotted. The main change applied at this stage was the final cartographic presentation, which comprised the notion of “choroplethic” map instead of the purely line map, currently produced at this scale. For this achievement, some experimental techniques were put in practise.

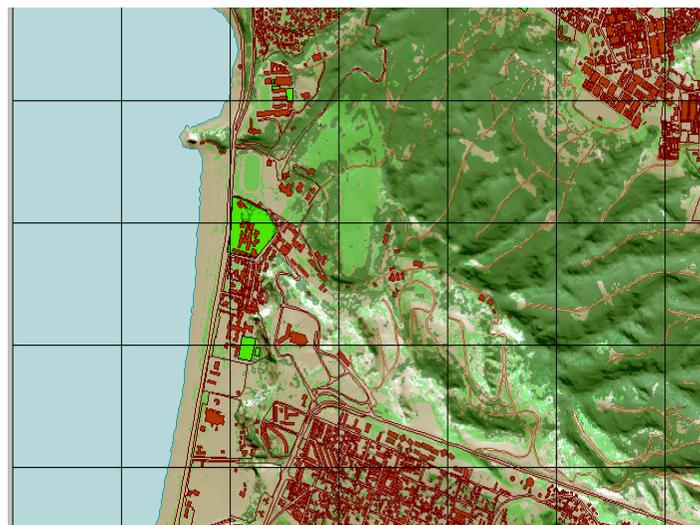


Figure 8. choroplethic stereo plotting at 1/5000 map scale

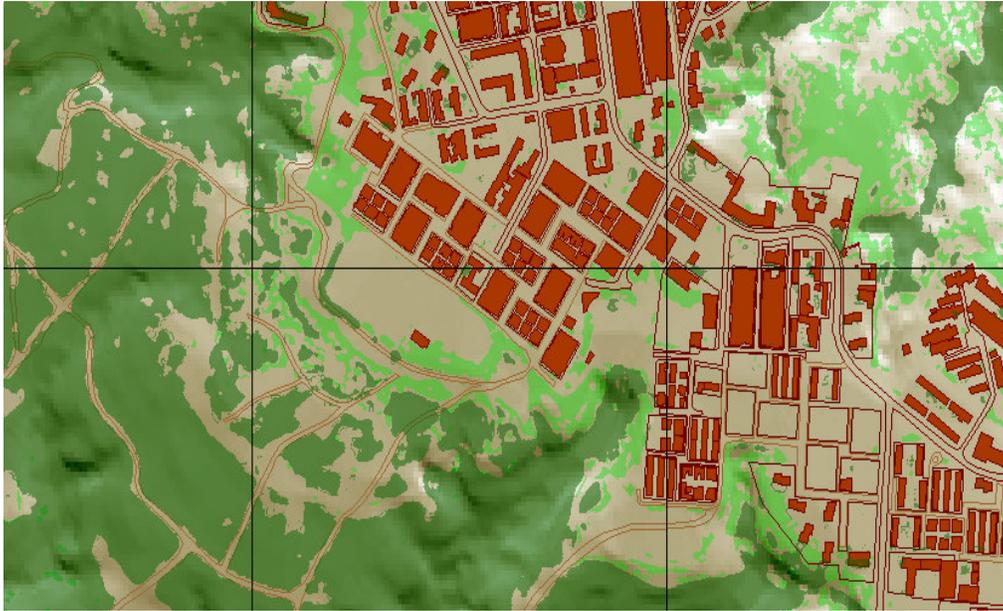


Figure 9. The choroplethic map presentation using hill shading, automatic vegetation capture (bushes and forest) to enhance the object nature perception.

They included masking techniques for the sea presentation; hill shading as the basic terrain appearance and automated vegetation extraction from the orthophotos, using colour segments. The observed outputs largely improved the object nature perception compared to line maps, as presented in figures 8 and 9.

Conclusions

This long term study carried out by the Universidad de Valparaíso allowed to put in practise new techniques for cartographic presentation and visualizations, jointly with rigorous metric map production (orthophotos). In one hand, these type of experiences are widely useful towards improving the existing ways of land presentation. In the other hand, this project supplied solutions community, who can take the advantages of possessing faithful territorial elements. Many of this project outputs will be freely used by technical staffs related to land administration or land planning, or by simple users that frequently demand geographic information. Perhaps the most remarkable difference related to a regular cartographic production lies on the fact of experimenting new techniques for geographic information presentation, which can be accepted as tentative changes for future maps. Economical resources provided by national organizations to universities, and joint experiences with national map production divisions will surely improve the quality of maps.

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