Visual Explorations in Real Estate Landscape

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Abstract – *Transparency in real estate market is important. It is not always so clear what is going on. Unique real properties are sold and the information about the wide diversity of things contributing in the sales price is not easily available.*

Two proposals were made to improve the cadastral system in the National Land Survey of Finland. Firstly, resembling sales are organized as valuations *and these are available for all real properties. Secondly, neighboring sales are organized as* groups *and these are available for fast local analysis.*

Sales price topography with peaks and valleys is visualized and attractive and disturbing objects are analyzed. Results for eight categories of landscape objects in recreational parcels are given.

Key words – Kohonen Map, appraisal, valuation, landscape, scenery

1 Introduction

It has been said that the first prerequisite for a country to develop is the cadastre. Information of real properties and their ownership is fundamental for establishing a functional economy. The quality of the cadastre indicates the level of development in other sectors of the society.

The second prerequisite for beneficial development may be the transparency in real estate market. Real property sales are recorded and market information is made available. Long term development and sales price levels for all kinds of land are important for financial decisions. Real properties are used as security for the repayment of loans. This mortgage use is essential for a country to get money for investments.

Compared to stock market it is much more difficult to collect information from real estate market. Real properties are unique, land use may be controlled, market supply and demand may be somehow restricted and the qualities of the parcels may vary drastically.

Kohonen Map [1] has been shown to be an effective and versatile paradigm, tool and method for analyzing and supplying real property market information [2]. Resembling or comparable sales are organized in a lattice of codebook units in a topological order. Typical sales prices are found with their typical qualities in locations pointed out on the map.

Long term development of sales prices can be analyzed. Recognition of structural changes in the market is important to determine if the prices are going up or down. Especially the turning points between boom and decline are liable to all kind of remarkable structural shifts. Kohonen Map is used to recognize the typical units in the transactions and actual sales can be compared to the most resembling sales in long periods, too.

Landscape is usually understood as visual scenery. Topographic forms of the terrain with hills, peaks, valleys, rivers and roads are things recalled as essentials for a landscape. In addition to this the voices, sometimes even scent and vibration may be prominent components. The auditory landscape may sometimes be more dominating than the visual landscape.

Land value can be looked as a landscape, too. Attractive sites are seen as ridges and peaks and respectively some areas are seen as valleys. Sales price topography is usually a continuum without crisp boundaries. Parcels and land use plans and restrictions do have crisp boundaries but resembling parcels have each own unique location and variables related to the neighborhood may be changing continuously.

2 Proposal Number One: Valuation

Two proposals were made to improve the cadastral system with land value information. The first and key proposal is to organize real property sales according to their qualities. This organization is made using the Self-Organizing Map or Kohonen Map algorithm.

2.1 The Valuation

Comparable sales organized as a unit of a reasonable scaled Kohonen Map is termed **valuation**. Valuation is a class in an object-oriented data model inheriting from same super class with real property and sales observation and includes:

- Typical sales price for the real property
- Typical location as geographic coordinates
- Typical qualities observed in resembling sales
- List of resembling observations in the geographical neighborhood
- Six nearest valuations in the topological neighborhood
- Deviations in sales prices contributed to matching sales
- Symbol showing up to twelve components taking place together

Coding and scaling of components is important and the effects are described in the net publication [2] with a lot of examples. Geographic location used as scaled coordinates is balanced with other components, for example the year of construction and the size of the building. Resembling observations are found in a wider neighborhood. Practical way may be to extend the distance to about five times the distance of neighboring sales.

The number of units in a Kohonen Map may be about one third of the number of observations. One observation belongs in a hexagonal neighborhood of seven units. The number of resembling sales in one valuation is about 15 to 25 and this has been experienced as useful in practice.

Local valuations are computed and shown as needed for groups of neighboring sales. The number of units in the Kohonen Map may be the same as the number of observations. Local exceptional sales are isolated and the spectrum of low and high price sales can be visualized nicely.

2.2   The Symbol for Valuation

Graphic variables are used intensively in map creation and old traditions of the art of cartography have developed the expressive power of portrayal during hundreds of years. It is quite natural to use graphic variables intensively in visualization of Kohonen Maps, too.

The symbol of real property may have four parts:

- Circle
  - Area of the circle shows the sales price.
  - Color may indicate category of real property.
  - Sectors may indicate timber volumes.
- Rectangle
  - Area of the rectangle shows the size of the building.
  - Shades of saturation show the year of construction.
  - Line width may indicate standard of equipment and condition.
  - Color may indicate qualities and improvements.
- Parallelogram
  - Area of the parallelogram shows the parcel area.
  - Thick line shows official plan.
  - Dashed line shows parceling out not done.
- Lake symbol
  - Shows the size of the lake.
  - Line width may indicate shore and condition.
  - Color may indicate distance to shore.

The symbol is essential to show the things existing together. Graphic variables are used. Visually greater values are used for greater values of the components. Component values as such can be chosen as valuation symbol, too. Topological groups and their meaning are clearly visualized when up to 10 or 12 components are seen together. Drawing the valuation symbols on the geographic map shows the differences in location.

3   Proposal Number Two: Group

The second proposal is to organize real property sales according to their location. This organization is made using the Kohonen Map algorithm.

3.1   The Group

Neighboring sales organized as a unit of a Kohonen Map using geographic coordinates only is termed **group**. Group is a class in an object-oriented data model inheriting from same super class with real property and sales observation and valuation and includes:

- Average sales price for the real property in a given location
- Average location as geographic coordinates
- Average qualities observed in neighboring sales
- List of observations in the geographical neighborhood
- Six nearest groups in the neighborhood
- Average deviation (ratio and difference) in sales price
- Symbol showing the local undulation (percent)

Neighboring sales are found using geographic coordinates only. Units with no own observations separate more or less distinct regions. Distribution of the observations is roughly preserved and the sizes of the groups are usually nearly equal.

Practical way may be to use about 20 to 50 neighboring sales for one group. Isolated observations and dense locations cause deviations from average numbers. Due to topological neighbors the number of units in a Kohonen Map may be about 1/3 to 1/5 of the number of observations.
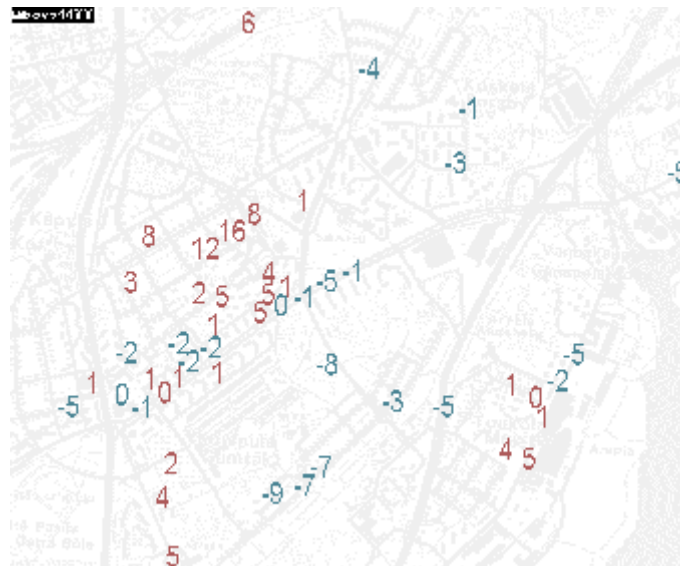

Figure 1. *Local sales price undulations (percent) in Käpylä.* The groups of neighboring sales are buttons to show local valuations. Peak of the landscape is shown in property values. Peak of the physical landscape is 500 meters to the north in Taivaskallio. Vanhankaupunginkoski is 1.5 kilometers to the east. © National Land Survey of Finland. 49/MYY/05

3.2 Motivation for the Group

Location is something very essential in real estate business and is analyzed thoroughly in the net publication [2]. Firstly, the groups are useful as regional statistics. In addition to average sales prices in a given location average values of other components can be seen. The landscape of real properties may be understood better if the qualities of the sites are known.

Secondly, **local sales price undulations** are computed in groups. Actual sales price in the neighboring observations are compared to the matching valuations and the average sales price ratio or difference is recorded in the group and used as group symbol on the map. Local undulations can be clearly seen.

All kinds of real properties in a given location are compared to their valuations from resembling sales in a wider neighborhood and the difference indicates all positive and negative characteristics in a given location. Symbol for negative undulations may be blue and for positive red. An example is given in Figure 1.

Thirdly, the groups are used on the map for local market analysis. Pointing out the symbol organizes a local Kohonen Map on demand. The whole spectrum of local valuations is visualized and the qualities of high and low price sales can be browsed. Matching valuations organized from a wider neighborhood are available as scatter plots and lattices, too.

4 Landscape and Scenery

The valuations and the groups can be used to analyze landscape and scenery more thoroughly. There are five stages described in the net publication [2] to analyze location and sales price using the Kohonen Map.

4.1 Five Stages to Analyze Location

Firstly, the group gives average local statistics for the real properties in the location. The distribution of observations is more or less preserved and the sizes of the groups may be nearly equal. First impression where the market is and what kind of objects there are is obtained.

Secondly, local sales price undulations give the impression of the smooth changes in the landscape. Average deviations in the sales prices compared to land value in a wider neighborhood indicate all positive and negative characteristics present in the landscape. Certain attractive or disturbing sites can be uncovered.

Thirdly, profiles according to distance are computed. One-dimensional Kohonen Map is used to organize sales observations according to distance from interesting objects or object categories chosen from the geographic map. Local sales price undulations are taken into account and only the deviation in addition to these is shown in the profile.

Fourthly, consecutive time windows are used. Long-term average values recorded in the valuations are the basis for comparison. Sales made in a certain time period may be deviating differently depending of the part of the city or country. This is visualized using Kohonen Map organized according to location and the deviation symbols give an impression of the variation in sales price development and changes over time.

Fifthly, smallest and largest values of a chosen component are used to analyze the effect of the component on its border. The units of the Kohonen Map are mostly located inside the observation space and there is a small difference in sales price and in the chosen component at the border. The ratio of the difference gives an idea of the cost of the change of one unit in the component.

Observations are organized according to location using Kohonen Map. Moderate sized groups are further organized according to a given method or component using one-dimensional Kohonen Map. Sales with smallest and largest values are compared to their matching valuations and the effects are visualized.

4.2   Deviation Profiles in Recreational Parcels

Seven categories were chosen by Pekka Rahkila to analyze the effects of landscape and scenery in real estate sales prices. The distances to 11.804 recreational parcels [3] were computed using digital map. These parcels are analyzed in the net publication [2] including analysis for high voltage transmission line in addition of the seven chosen categories.

Results are reported in the net publication [4]. Recreational sites are very sensitive to all kinds of disturbing activities or institutions. Open space and natural environment is favored and manmade constructions are tolerated less than in urban areas. Following qualitative results were obtained:

- Motorway. Negative deviations up to average 20 percent were seen up to at least 2.5 kilometers. Overall positive effect of four percent up to 3 kilometers may indicate fast and good connections and neighborhoods with high demand on land.

- High voltage transmission line. Within a distance of 300 meters the property values may have a negative effect of 10 or 20 percent or more. Negative deviations were dominating up to at least 2 kilometers from the transmission line. An overall negative effect of one percent is seen up to distance of 3 kilometers, two percent up to distance of 600 meters and three percent up to distance of 300 meters.

- Quarry. Negative deviations up to average 20 percent were seen up to 800 meters. Overall negative effect of two percent up to 2 kilometers may indicate that a quarry does not belong in the neighborhood of best recreational areas.

- Fence. Negative deviations up to average 20 percent were seen up to 250 meters. Overall positive and negative effects compensated each other.

- Main road. Negative deviations up to average 15 percent were seen up to 500 meters. Overall negative effect of 1.5 percent up to 3 kilometers may indicate that a main road does not belong in the neighborhood of best recreational areas.

- Cell phone tower. Negative deviations up to average 10 percent were seen up to 700 meters. Overall positive effect of two percent up to one kilometer may indicate good connections to reach people physically, too (Figure 2).

- Gravel pit. Negative deviations up to average 10 percent were seen up to 400 meters. Overall negative effect of one to three percent up to 3 kilometers may indicate that a gravel pit does not belong in the neighborhood of best recreational areas.

- Embankment. Negative deviations up to average 10 percent were seen up to 200 meters. Overall positive and negative effects compensated each other.
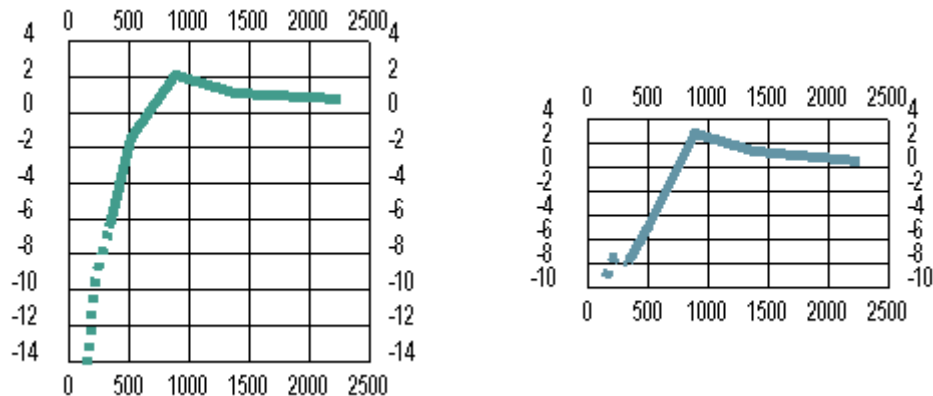
Figure 2. *Cell phone tower profile*. Average sales price differences according to distance (meters, horizontal axis) are shown in percent (left, vertical axis) and in FIM 1000 (right, vertical axis).

Contradictory positive effects were seen in the profiles for the:

- fence from 0.4 to one kilometer
- main road from 0.5 to 1.5 kilometers
- tower from 0.8 to 1.5 kilometers
- gravel pit from 0.5 to 1.5 kilometers
- embankment from 300 to 1000 meters

This may indicate something positive in the neighborhood, for example good connections or an area with higher demand on land. Contradictory effects are averaged in the profiles.

4.3   Some Remarks in Dwellings in Helsinki

Local sales price undulations in dwellings in Helsinki show many interesting views. One example of local undulations and landscape is taken from Käpylä (Figure 1). Positive and negative characteristics are averaged and remarkable difference in sales price level is seen between two neighboring locations.

The attractiveness of **Käpylä** originates from the unique and coherent construction style of wooden buildings. Old trees and beautiful gardens are essential parts in the landscape. One thing intensifies the harmony in the peak of the sales price undulation: the only curved street gently sloping where horizontal and vertical inflection points coincide.

Two other interesting sites are found in the vicinity. **Taivaskallio** is located about 500 meters to the north from the peak (southeast from railway on the figure 1). The physically highest natural place in Helsinki is located close to the main railroad (140 meters) with local railway station and the motorway Tuusulanväylä (380 meters). A high voltage transmission line of 110 kV (130 meters) can hardly be seen in the valley behind the old and beautiful trees. Harebell (Campanula rotundifolia L.) and field forget-me-not (Myosotis arvensis L.) are some of the characteristics accomplishing this landscape for me personally as one of the best in Helsinki.

Vanhankaupunginkoski is located about 1.5 kilometers to the east from the peak (center right on the figure 1). River Vantaa is analyzed in the net publication [2] and the profile shows clear positive impacts of the green corridor.

The River Vantaa erupts into the Baltic Sea in a beautiful rapid and waterfall followed by an arch bridge. Electric power production in a museum and other buildings of the heritage environment are essentials in the landscape. Nevertheless, a little bit surprising, the high voltage transmission line of 110 kV (seen in Taivaskallio) is planned to be removed into a tunnel as a part of residential development.

5   Concluding Remarks

Real estate landscape can be analyzed using Kohonen Maps. Traditional comparable sales approach in appraisal is realized. Resembling sales in the neighborhood are organized as valuations. Smooth undulations in the sales price topography are visualized using groups of neighboring observations.

All positive and negative aspects and characteristics are present in a location. The whole is not the sum of the parts. At one's best the average deviations given in this paper may give some advice to understand the impacts of disturbing objects in the vicinity of real properties.

Quite an other question is what objects are disturbing and why. All people do not perceive the environment with similar aspects and values. Especially aesthetic values may be difficult to quantify. Technical constructions may be of interest to someone and annoying to others. The effects of noise, dust and gas vary.

More complicated questions arise with the people who live in the neighborhood. Resembling insights of what is important may cause likeness in both physical and mental landscape. New and unexpected things may be found between familiar ones. Loved people may increase the quality of life. Sales price topography is a continuum. Attractiveness of a site seen as hills and peaks may be the force to even intensify the undulations.

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