

# Smart Surveyor for Property Assessment

## - the Use of Geographic Information Systems in Real Estate Assessment in the Netherlands

HERMANS, Luc, D. B.Sc., Ir. KATHMANN, Ruud M. and Ir. KUIJPER RO, Marco,  
Netherlands

### ABSTRACT

The annual assessment of real estate is a municipal responsibility in the Netherlands. To put this in perspective, 355 municipalities are responsible for the assessment of over 9 million residential and non-residential real estate properties. The assessment industry in the Netherlands is to this day heavily reliant on spreadsheet thinking which is at least remarkable due to the spatial nature of real estate and thus to the fact that the mass appraisal process primarily uses geographical data.

Current legislative and juridical developments are driving the municipalities to move away from the spreadsheet thinking towards a more geospatial way of thinking. One of these developments is the juridical decision to exempt the core zone (or formal maintenance zone) of dyke bodies from real estate taxation. These dyke bodies are often part of privately owned, often residential properties.

To identify the affected real estate properties for this exemption, in a short period, the use of geographical information systems became a more mainstream practice in the Dutch assessment industry. Because of this development, tax departments of municipalities were (more or less) forced to work together with the GIS-departments, or to hire GIS-knowledge from private companies.

The Netherlands Council for Real Estate Assessment sees this development as a good gateway towards a broader use of geospatial information and geographic information systems in the assessment industry. The use of GIS in real estate assessment has a wide range of possibilities such as data gathering (for instance distance to important facilities or orientation toward the south), data quality control (unexpected differences in building year for adjacent houses) and more ambitious implementations such as the incorporation of spatial statistics in automated valuation models.

This paper will discuss how geospatial data and information systems are used in the Dutch assessment industry at this point in time and it will address possible avenues of further development and applications within the assessment industry. Furthermore, it will discuss how legislative and juridical decisions can be a driver for increased use of geospatial ways of thinking.

**Keywords:** Geographic Information Systems, GIS, Real estate assessment, Valuation

## 1. INTRODUCTION

Geographic information systems (GIS) have been around for a couple of decades. In the early years, the use of GIS has been mostly restricted to specialist working on dedicated workstations. However, with the increase of computing power in normal laptops, personal computers and other handhelds and the simultaneous drop in costs of these powerful computers more people are able to make use of a GIS and have become familiar with GIS. From the turn of the century, the next important step in the democratization of spatial data use was made with the launch of Google Earth, bringing digital maps to the masses. In the years after the launch of Google Earth, many other computer based free mapping applications became available.

There are many different definitions of Geographic Information Systems (GIS) in academic literature. This paper follows the definition of Heywood et al. (2011) which states that a GIS is a computer system which can analyze, manipulate and visualize spatial data.

Straightforward applications of GIS such as visualization of data can help detecting corrupt data within the datasets. This is a very important functionality for mass appraisal because the appraiser must be able to rely on the quality of his data when calibrating the valuation model. Visualization can also help with the communication towards the taxpayer ultimately resulting in fewer appeals being made.

The most recent years are characterized by a wider availability of (open) spatial data and open GIS functionality. This trend in combination system with open source GIS-platforms such as QGIS or GRASS GIS meant the last big obstacle for making the move from spreadsheet thinking to spatial thinking is gone. The address based data bases for appraisal can easily be transformed to a GIS so all available data can be analyzed using the spatial techniques and the data can be enriched with open data on the location of the properties.

The phrase location, location, location is one of the most characterizing phrases of the real estate industry. Unfortunately, the real estate assessment industry in the Netherlands is still stuck in the era of spreadsheet type appraisal systems. This paper aims to introduce solutions for the most limiting obstacles to make the transition to a spatial driven approach on real estate assessment. Specifically this paper will focus on the Dutch context, however the theory and solutions explained are also applicable in other context be it with some slight changes.

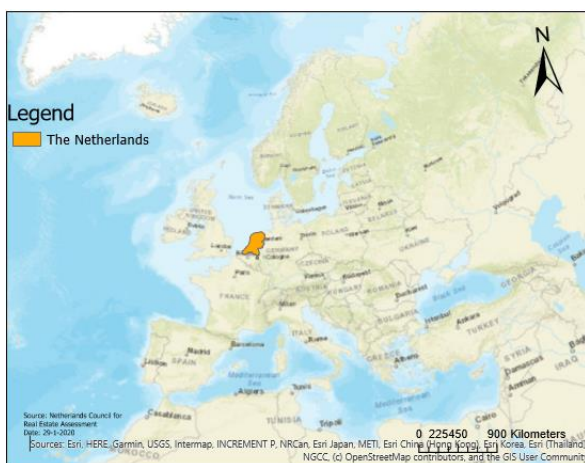
First off al, the real estate assessment industry in the Netherlands will be briefly introduced. Thereafter, the availability of (open) data in the Netherlands will be explained. Subsequently, some GIS-platforms will be introduced along with their advantages and disadvantages for applying in the assessment field. After this some different visualization, strategies will be discussed. Ultimately, we will focus on more advanced GIS uses.

Parts of this paper are also published in Kathmann and Kuijper (2006; 2015;2016) and in Kathmann, Kuijper and Hermans (2020).

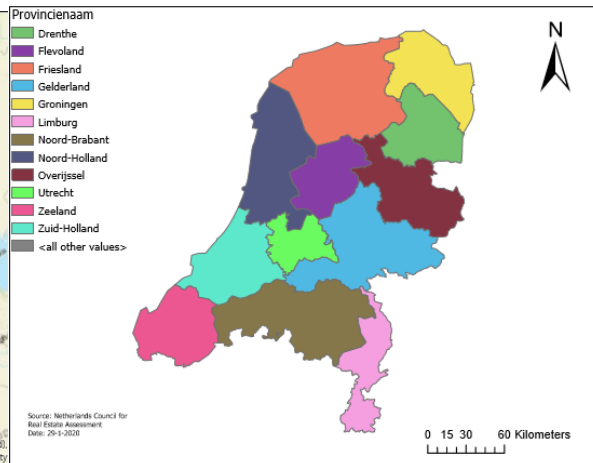
## 1.2 The Netherlands

With roughly 17.5 million inhabitants and an area of 41.543 km<sup>2</sup>, the Netherlands is a densely populated country located in Western Europe. The Netherlands has three layers of government: the central government, the regional (provincial) government and the local government:

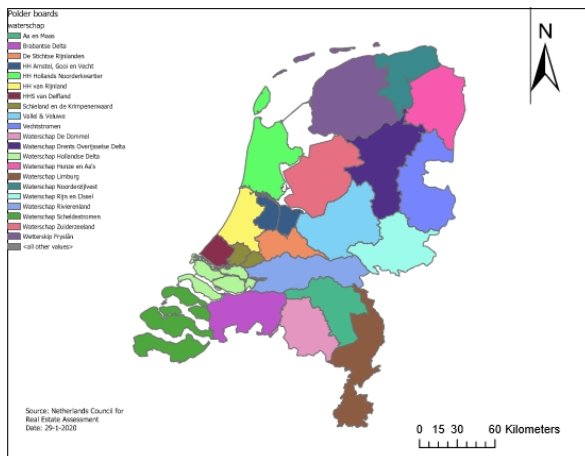
- The central government consist of the administration, departments and advisory committees. The current cabinet has 16 ministers for 12 departments.
- The decentralized government consist of 12 provinces, that form the regional government, and 21 polder boards and 355 municipalities. The municipalities and the polderboards are both types of local governments and spread the whole country. The figures 1 until 4 show the distribution of the governments.



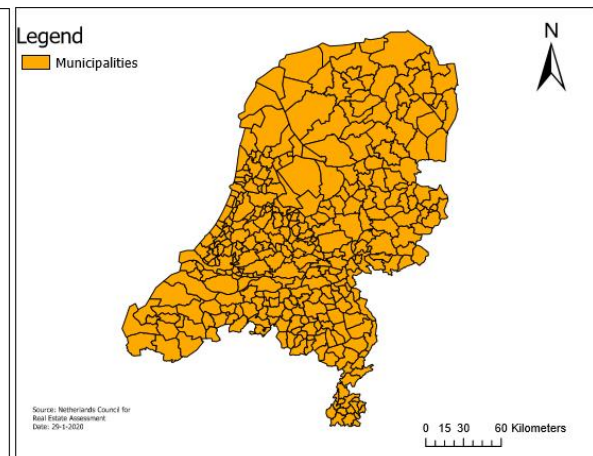
**Figure 1. Location of the Netherlands**



**Figure 2. Provinces of the Netherlands**



**Figure 3. Polderboards in the Netherlands**



**Figure 4. Municipalities in the Netherlands**

Both the central, regional and the local government have the authority to levy taxes and in doing so the central and both local governments make use, among other things, of the value of real estate properties for these taxes. Up until 1995, the various authorities were individually

responsible for the assessment of the real estate property values for their taxes. These various authorities applied several methods and definitions. This had different values as a result. From 1995 based on the Act for Real Estate Assessment all levels of government use the same assessment for their property tax.

---

Smart Surveyor for Property Assessment (10425)  
Luc Hermans, Ruud Kathmann and Marco Kuijper (Netherlands)

FIG Working Week 2020  
Smart surveyors for land and water management  
Amsterdam, the Netherlands, 10–14 May 2020

### 1.3 Property taxes in the Netherlands in numbers

In 2018, approximately 10.7 billion euro has been levied in real estate taxes. As stated in the introduction, the assessed value is not a tax in itself; however, it does serve as a tax base for both local and national taxes. The table below lists the approximate levied taxes for 2018 sorted by type of tax.

Table 1: Levied taxes, based on the assessed value (all amounts are in millions)

	2014	2015	2016	2017	2018
Municipal property tax	€ 3500	€ 3600	€ 3700	€ 3800	€ 3950
Property tax polderboards	€ 600	€ 650	€ 660	€ 675	€ 725
Assessed value as a part of the income tax	€ 2450	€ 2500	€ 2550	€ 2650	€ 2650
Assessed value as a part of the wealth tax	€ 1000	€ 1000	€ 1000	€ 1000	€ 1000
Assessed value as a part of the inheritance tax	€ 650	€ 650	€ 650	€ 650	€ 650
Landlord tax	€ 1100	€ 1400	€ 1600	€ 1700	€ 1700
Total	€ 9300	€ 9800	€ 10.160	€ 10.475	€ 10.675

### 1.4 The valuation process in The Netherlands

On January 1st, 1995, the Special Act for Real Estate Assessment (in Dutch: Wet WOZ) was initiated. This law had the purpose to establish legislation for the definition and documentation of real estate property values for various taxes. The Special Act for Real Estate Assessment aims to realize the following purposes: efficiency, clarity, quality and uniformity. Initially the Special Act for Real Estate Assessment determined that all municipalities had to assess the value of all real estate properties every four years and that it was mandatory for other government organizations to use these assessed values for their taxation purposes. Therefore, the law got rid of the differing values of the years before 1995. As of 2007, an annual appraisal has been introduced, because at that time the mass appraisal systems were developed enough to support the annual valuation. This annual appraisal and assessment is done with the value reference date set one year prior to the year of use. The Council for Real Estate Assessment is an independent government organization that supervises and monitors the quality of real estate property assessment.

Given the specialized character of the mass appraisal process an important part of the work is not done by "regular appraisers" but by specialists in the field of defining and optimizing models (statistics and econometrics) and specialists in the field of data management.

In 2006, it was decided to make the WOZ-registration (Registration of assessed values) part of the System of Base Registers that was under construction for all government organizations in the Netherlands. In doing so, the municipal registration of assessed values became a part of the public sector information system, which now consists of 11 base registrations that are connected with each other. This decision also had consequences for the work procedures underlying the maintenance of public sector information. These work procedures are increasingly being connected with one another. There are, for example, base registers available about the cadastral situation (ownership), the registered persons (inhabitants) and about businesses. These registers have been there traditionally, but have been modernized in recent years and have been implemented in the System of Base Registers as mentioned above, of which the registration of assessed values is an integral part. Thanks to this integration all assessed properties are now also linked to other spatial objects like buildings and cadastral parcels. Within this system the assessed value has become real spatial data.

Finally, a digital infrastructure has been developed in The Netherlands of which central and local governments are obliged to make use when designing their digital service towards citizens and businesses. Government organizations are using this digital infrastructure to improve their data exchange and to offer their digital services in a reliable and safe manner. For instance with this digital infrastructure each inhabitant in the Netherlands has a safe digital letterbox to receive (confidential) letters of any government agency.

### **1.5 The Netherlands Council for Real Estate Assessment**

The Netherlands Council for Real Estate Assessment is an independent organization that supervises and monitors valuation in the context of the Special Act for Real Estate Assessment. If municipalities do not meet the minimum quality standards as set by the organization, it is initially the municipal council, which will be held accountable. If the necessary improvements are not being realized, the Minister of Finance may, in extreme cases, decide to have this Act executed by another party instead of by the municipality. The Netherlands Council for Real Estate Assessment wants to improve the trust in the execution of the Special Act for Real Estate Assessment, among other goals, by:

- promoting that the object characteristics used in the "WOZ-valuations" are consistent with the data in de system of base registers and can be seen as the building blocks for the data within the coherent registration of building and all other physical objects within the system of base registers;

- realize that the municipalities, as a part of their valuation process, make use of available data (open data), in particular data with regard to the location of properties.

## 2. AVAILABILITY OF (SPATIAL) DATA IN THE NETHERLANDS

### 2.1 PDOK

The Netherlands is a small but very densely populated country. From the start of the country land registrations have been managed, maps have been made for trade or the reclamation of land. This longstanding relationship with keeping track of spatial data has resulted in a situation where the full extent of the country is covered by many specific and high quality datasets. Many of these datasets can be found in the dedicated search platform, which is called *Publieke Dienstverlening Op de Kaart* (PDOK), a quick translation would be Public Services on the Map.

PDOK has been launched in 2013, in the first year it had 0.48 billion hits. By 2019, PDOK had over 14 billion hits over the year. The platform serves 192 datasets, 505 services and 103 INSPIRE services. Furthermore, in 2019 PDOK was up and running for 99.71% of the time and had only five interruptions which took longer than a half hour. For that reason PDOK can be seen as a reliable source of data for the assessment industry. Figure 6 gives an impression of the search tab in PDOK; it shows the availability of two versions of the national height model dataset.

The screenshot shows the PDOK search platform interface. At the top, there is a dark blue header with the PDOK logo on the left and navigation links: Actueel, Over PDOK, Voor aanbieders, Contact, Datasets, PDOK Viewer, Inspiratie, Community, Support, PDOK Next, and NGR. Below the header, the main content area is divided into two columns. The left column, titled 'Thema', lists various categories such as (Civiele) Structuren, Binnenwater, Economie, Geo Wetenschappelijke Data, Grenzen, Hoogte, Landbouw en Veeteelt, Locatie, Maatschappij, Natuur en Milieu, Oceanen, Planning Kadaster, Referentie Materiaal Aardbedekking, Spreiding van soorten, and Transport. The right column, titled 'Zoeken', contains a search bar with the text 'datasets zoeken'. Below the search bar, two search results are displayed. The first result is 'Actueel Hoogtebestand Nederland (AHN1)', with a description: 'Het Actueel Hoogtebestand Nederland (AHN) is een hoogtebestand vervaardigd door middel van laseraltimetrie.' Below this, there is a table with three columns: 'Thema' (Hoogte), 'Organisatie' (RWS), and 'Ontsluitingen' (Geo Services / Downloads). A 'Details bekijken' button is located below the table. The second result is 'Actueel Hoogtebestand Nederland (AHN2)', with the same description. It also has a table with 'Thema' (Hoogte), 'Organisatie' (RWS), and 'Ontsluitingen' (Geo Services / Downloads), and a 'Details bekijken' button below it.

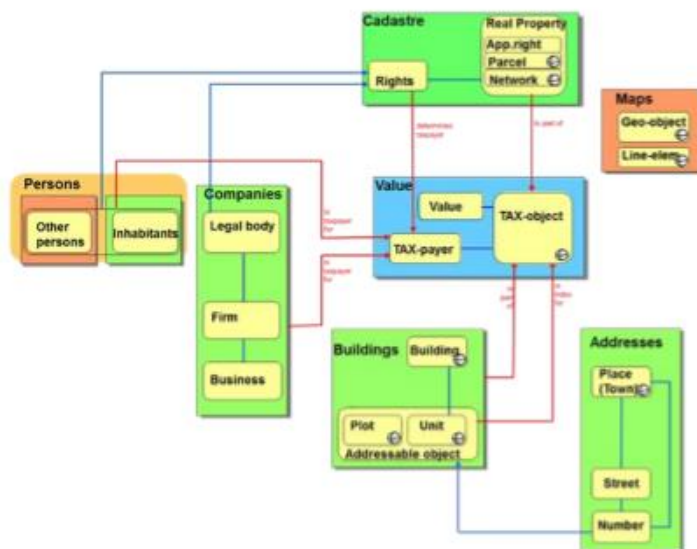
**Figure 6. PDOK search platform (source: <https://www.pdok.nl/datasets>).**



## 2.2 Dutch system of base registrations.

In the assessment industry, some of the most important aspects are data on parcels and addresses (buildings). In the Netherlands, these data is part of the system of base registers that is used by the different government institutions. For this system of base registers agreements have been made on who is responsible for the maintenance of which part and type of the dataset. The responsible government agency keeps the dataset complete and up-to-date by normal procedures for collecting new data and change detection but also by procedures for quality control. On the other hand government users of the dataset are obliged to inform the responsible government agency if they think the data is incorrect. Some parts of the system are also available as open data to private organizations and inhabitants. Also private organizations and person are allowed (but not obliged) to possible errors in the datasets This results in a self-cleaning system, which registers all key data elements for many different government and non-government uses.

One of the base registers that is essential for mass valuation in relation to the Special Act for Real Estate Assessment is the Base Register Cadaster. The ownership situation of all parcels is recorded in this central register. Because of the legal system in the Netherlands, the Cadaster gives complete information on the ownership of all properties. Therefore, the Base Register Cadaster is important source of information to set up and maintain a complete list of properties to be assessed (tax list).



**Figure 7. Parts of the base registration system connected to property assessment.**

In addition the market data (sale price), in case of a sale, is also included in this Base Register Cadaster. Therefore, the Base Register Cadaster is also an important source of market data.

The Base Register Addresses and Buildings is being used to identify buildings and associated primary object characteristics, such as size (usable floor area) and building year. Also the link

with the Base Register Addresses and Buildings is important to guarantee the completeness of the tax list. Each building in the Netherlands must be part of an assessed property

The Base Register for Values stores the assessed value for a tax-object, which can then be used by other government agencies.

### **3. GIS-platforms**

In the Netherlands, appraisers work with many kinds of different software. Most important are the software for data management, for calibrating the valuation model, for presenting data and communication with taxpayers, including sending out tax bills and for handling formal procedures. Unfortunately, in most cases the appraiser themselves do not use GIS-platforms. Municipalities, who are responsible for the annual assessment of real estate, do have access to GIS-platform most of the time in combination with a dedicated team for geospatial analysis. They use these platforms intensively for other working fields, but mostly not for the appraisal/assessment. This section will focus on the advantages and disadvantages of the use of paid and open source platforms for the appraisal profession.

#### **3.1 Paid GIS-platforms.**

There are many companies offering GIS-platforms for a wide range of aspects of the assessment processes. The GIS systems always give tools for data management and for quality control of data for instance by visual inspection in maps. Some GIS platforms also have functionalities to analyze market data and for building and calibrating appraisal models. Choice has to be whether the platform that will be used for the appraisal work, only needs the functionality, which was specified in the search. In this case, a dedicated solution would be sufficient and can still be low in costs. If the assessment department (perhaps in combination with a GIS-department) wants to keep on trying new ways to improve their use of spatial data, they can opt for a broad GIS-platform, which are often more expensive. For instance these platforms also have to possibility to use 3D data in the data management and the (market) analyses.

The main advantage of paid solution are the ease of use and the convenient ways to share maps and information. Companies providing the software are also willing to help improve the user experience. The main disadvantage are costs, paid solutions can become pricy.

### 3.2 Open source GIS-platforms.

Open source GIS-platforms became available a few years ago. These platforms can carry out all basic (and even more advanced) analyses and visualization, which would be of interest in an assessor's office. Learning curves for open source platforms are most of the time a bit trickier as opposed to the guided learning paths of paid solutions. However, there is no reason to be scared off as open source platforms usually have an active user base and resulting blogs. These communities and blogs can be a way to overcome the initial learning curve and can be the start to use geospatial data in the assessment office for cents on the dollar.

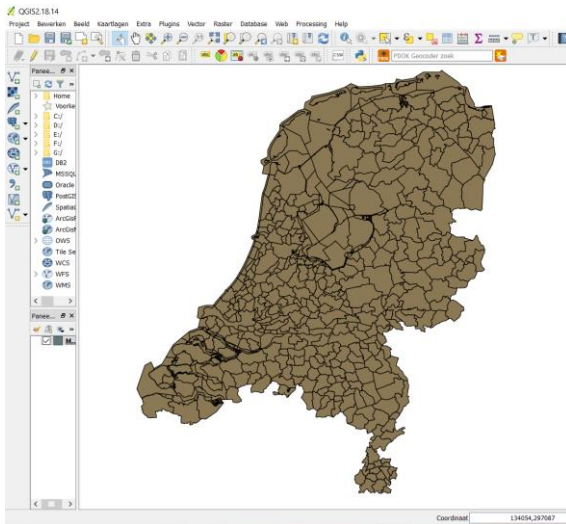


Figure 8. QGIS (open source)

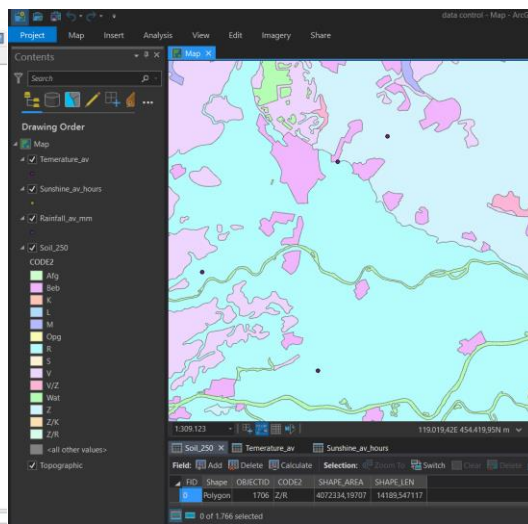


Figure 9. ArcGIS PRO (paid solution)

---

Smart Surveyor for Property Assessment (10425)  
Luc Hermans, Ruud Kathmann and Marco Kuijper (Netherlands)

FIG Working Week 2020  
Smart surveyors for land and water management  
Amsterdam, the Netherlands, 10–14 May 2020

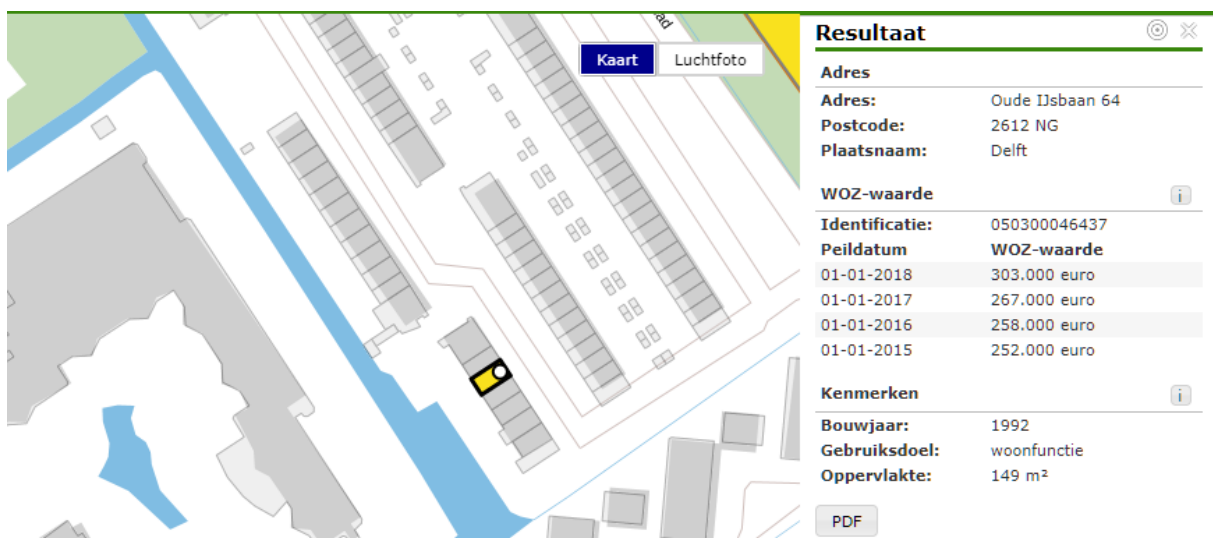
## 4. VISUALISATION

Cartography is one of the hardest aspects of using spatial data. There are many ways to go about communicating a message. For the ground bound properties visualization is rather simple by using the 2D geometry of the parcel. By coloring within the boundaries or placing symbols within these boundaries it is easy to read this kind of maps and select interesting properties. So for single family houses and larger business properties visualization is not a big issue.

In areas with many layered buildings, multi-family houses apartment buildings, multi-company buildings, the parcel approach may not be useful. Multiple apartments can be on the same parcel; this creates problems with visualizing data on specific apartments. In this case, one can use a point for visualizing spatial data on the apartment level. An underlying layer could be a parcel map.

Instead of the parcel, the building itself could also be visualized using a polygon structure. Also with this approach, choices have to be made. One could choose to use the building print at ground level as the defining boundaries for the representing polygon. Another option is to use the building outlines from overhead view as defining boundaries for the representing polygon. But within the GIS system working with 3D images is becoming more common.

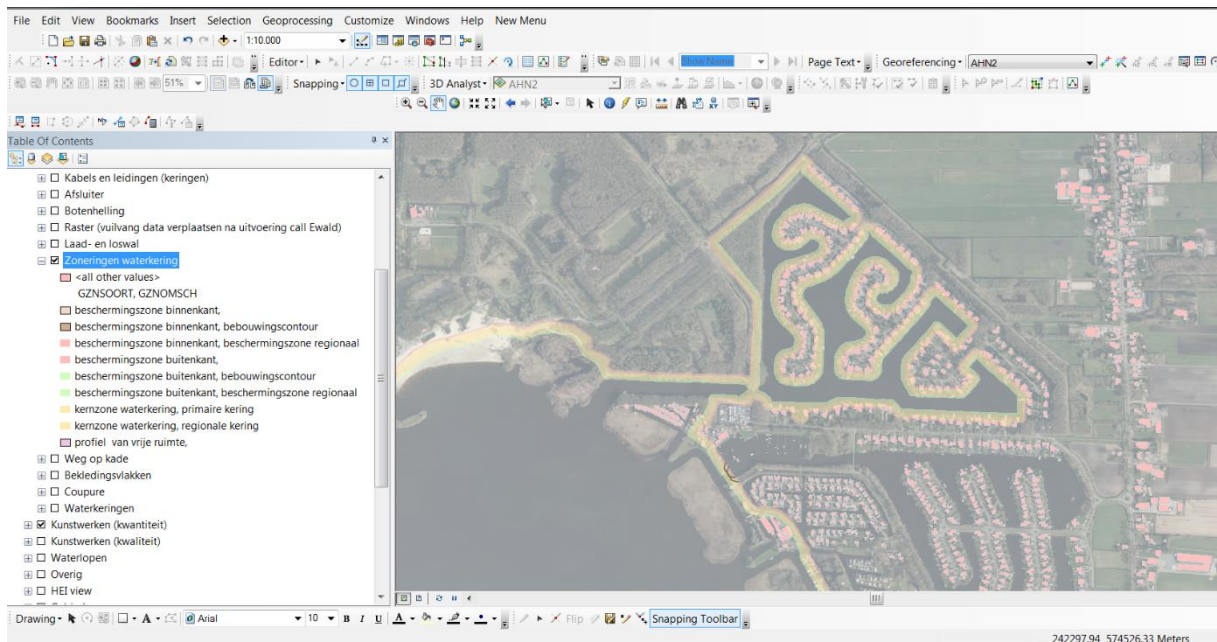
Unfortunately, there is no best way to communicate a (3D) message using maps. There are many ways to do it. The most important thing is that one must keep in mind to whom the message should speak and what it should tell. A map intended for a taxpayer should tell a different story (and must be easier to read) than a map intended for an appraiser. By asking for feedback, we can improve our communicative skills. It is important that both the mapmaker and the user stay in contact during the process to get to the best results.



**Figure 10. Easy to read map for taxpayers within the "WOZ-waardeloket.nl"**

## 5. ADVANCED ANALYSES

The way tax is levied on real estate is subject to legislative change and resulting exceptions. This means that under specific conditions some parts of a parcel might be exempted from the property tax based. In that case that part of the property should also be excluded from the valuation. A few years ago, a ruling by a Dutch judge resulted in an exception for the property tax for parts of a parcel, that form a part of the water defense system (small dykes on private properties). GIS proved to be a helpful tool to investigate whether a parcel was affected by this ruling and which part of the parcel should be excluded from the valuations and taxation.



**Figure 10. GIS analysis to visualize (and analyze) the effect of the exception of water defense structures.**

Another option for the use of Geographic Information Systems (GIS) in the assessment industry is to enrich our existing datasets with data from other spatial layers. This could mean mapping access to schools, the access to good public transit or even the distance to a hospital can help performing a market analysis in which the appraiser tries to investigate how these elements of "location" influence the sales prices and in that way the market value. All these aspects might have an impact on the value of real estate, however with spreadsheet thinking these aspects are rather hard to include and to analyze. The use of a GIS can be an easy way to enrich our knowledge of a certain property and its surroundings. One of the most famous expressions in the real estate world is "location, location, location.". GIS is the way to go to give these words action,

Another advanced analysis that can be fruitful for real estate assessment is the use of GIS to account for spatial autocorrelation in automated valuation models. Right now, most automated valuation models in the Netherlands are using a multiple regression analysis as

underlying analysis to create an automated valuation model. However, there are signs that a local regression analysis improves the automated valuation models relative to the global multi regression analysis.

## **6. ROLE OF THE NETHERLANDS COUNCIL FOR REAL ESTATE ASSESSMENT.**

The Netherlands Council for Real Estate Assessment does not itself create valuation model or perform market analysis. The Council as an oversight agency, is dealing with quality control. But in the view of the Council quality control also includes stimulating municipalities using useful tools in their activities for data management, market analysis and calibrating valuation models.

But GIS has proven also to be an useful tool for an oversight agency, because using the GIS analyses and visualization we can do a very fast check of data consistency of the data used by a municipality or the (spatial) consistency of the assessed values.

For that reason the Netherlands Council for Real Estate Assessment will:

- continue with incorporating GIS-platforms in our own work processes wherever possible;
- continue to do research on how GIS-platforms can improve the communication with tax-payers;
- provide help for municipalities who are looking to way to incorporate GIS-platforms in their own processes;
- continue to track developments on the use of GIS-platforms in the Netherlands and the international assessment industry.

## LITERATURE

Heywood, D., Cornelius, S. and S. Carver. 2011. An introduction to geographical information systems. Harlow: Prentice Hall.

KATHMANN, R.M. and KUIJPER, M. 2015; Property Valuation and Taxation in The Netherlands, A case study conducted by the Netherlands Council for Real Estate Assessment; The Hague, The Netherlands

KATHMANN, R.M. and KUIJPER, M. 2006; How to Evaluate Valuation Models?, The Hague, The Netherlands

KATHMANN, R.M. and KUIJPER, M. 2016; THE THREE KEY PRINCIPLES FOR MASS APPRAISAL: DATA QUALITY, DATA QUALITY AND DATA QUALITY; The Hague, The Netherlands

KATHMANN, R.M., KUIJPER, M, and HERMANS, L.D., 2020.: Smart Assessor: Keep calm and manage your data quality; The Hague, The Netherlands

## WEBSITES

<https://www.pdok.nl/datasets> (last used 4-february-2020)