Enabling time-travel through the history of the digital cadastral map from archived parcel maps

Tom WORTEL, Marcos BUIZA and Eric HAGEMANS, The Netherlands

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1. SUMMARY

The Dutch Kadaster was founded in 1832. A complete digital cadastral map, being the relative location of all parcels, of the Netherlands has been established at the beginning of the 21st century During the time between the 1990-s and 1832, the only way to create a digital map is to trace back the existence of parcels in local parcel maps (so called “hulpkaarten”.) This local parcel map is a map created by the surveyor describing, each time a parcel is split or merged, the parcel that ceased to exist and the new parcels that are established. Surrounding parcels are not presented on the local parcel maps.

In 2010, all parcel maps between 1950 and 2010 have been digitized and vectorized to create a complete cadastral map, consistent both in topology and in time. Since then, the Kadaster has been able to present a digital map of any moment in time, although such a map did not exist at that specific time. The product has known its flaws and inconsistencies, though.

Now, with AI and thanks to the KKN (Cadastral Map Next) project, Kadaster succeeded in correcting a lot of these flaws, and extend the period in which the map is available back to start of the first local parcel maps.

This is a major breakthrough and unlocks all kinds of possibilities. The most important of which is the possibility to automatically search our archives for field works related to any kind of boundary. Another great opportunity is the service notaries are provided with, being able to investigate the presence of a property right of easement, solely based on the location of the parcel and the parcels that have existed on a certain geographic location. Additional value creation is the user-friendly visual visibility of the origins of the history of parcels up to 1832 through a viewer. A lot of manual labour in performing these kinds of research can be spared.

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2. BRIEF HISTORY OF CADASTRAL MAPPING IN THE NETHERLANDS

Back in 1811, The Netherlands was annexed by France and Napoleon decided he wanted to tax private properties. This lead to the introduction of the Kadaster, which was completed in 1832. Back then, the registration consisted of minute plans, made up for each municipality and mostly centered around churches. These municipalities were divided into sections because an entire municipality would not fit on one map. Minute plans were drawn in the field and were finished back in the office. These plans are the first countrywide map that is available.

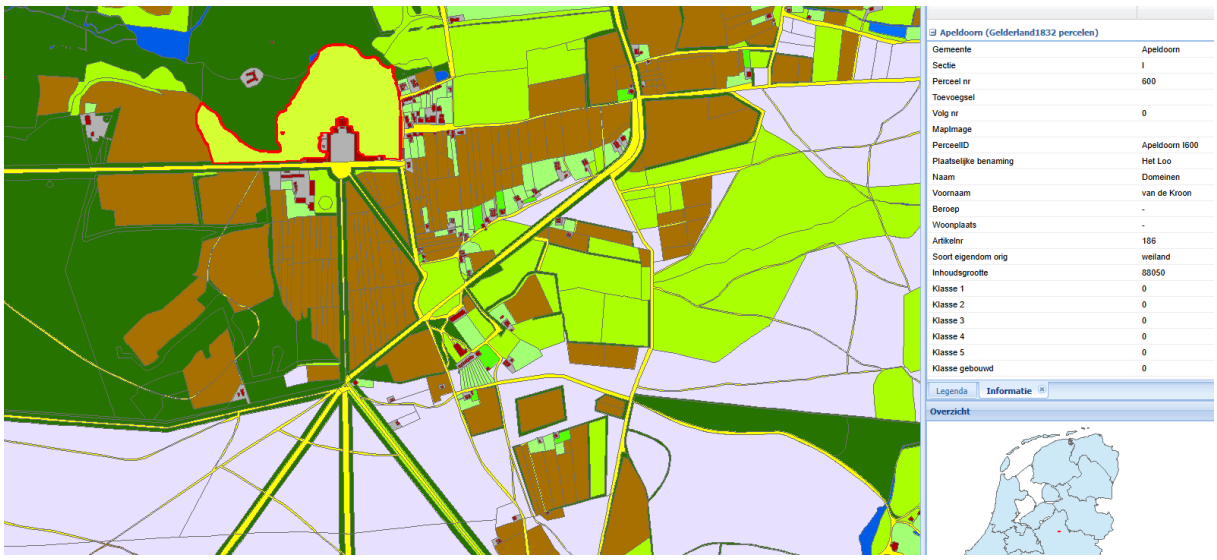

Figure 1: Modern presentation of minute parcels digitized from original minute plans

Actualization of the sections were yearly, and since the start, local parcel map of each change have been made. The local parcel maps indicate the new and old parcel numbers and boundaries that have been created in a specific year (or in later years, for each individual change).

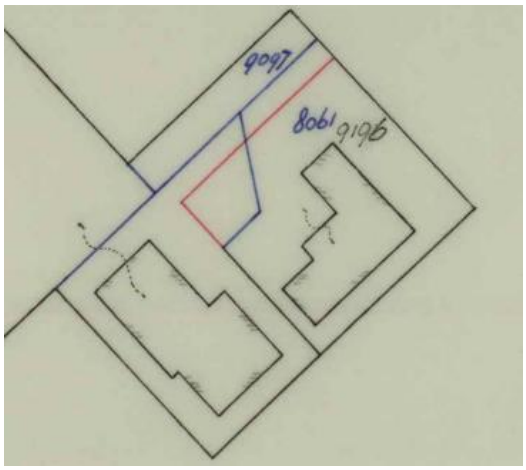

Figure 2: example of a local parcel map

After 50 years of working in this way, the Kadaster standardized the creation of field sketches containing measurements of each change as well. The reason is that the actual boundary became more important, not just the taxation of property. So the local parcel maps are the oldest logging of changes that we have.

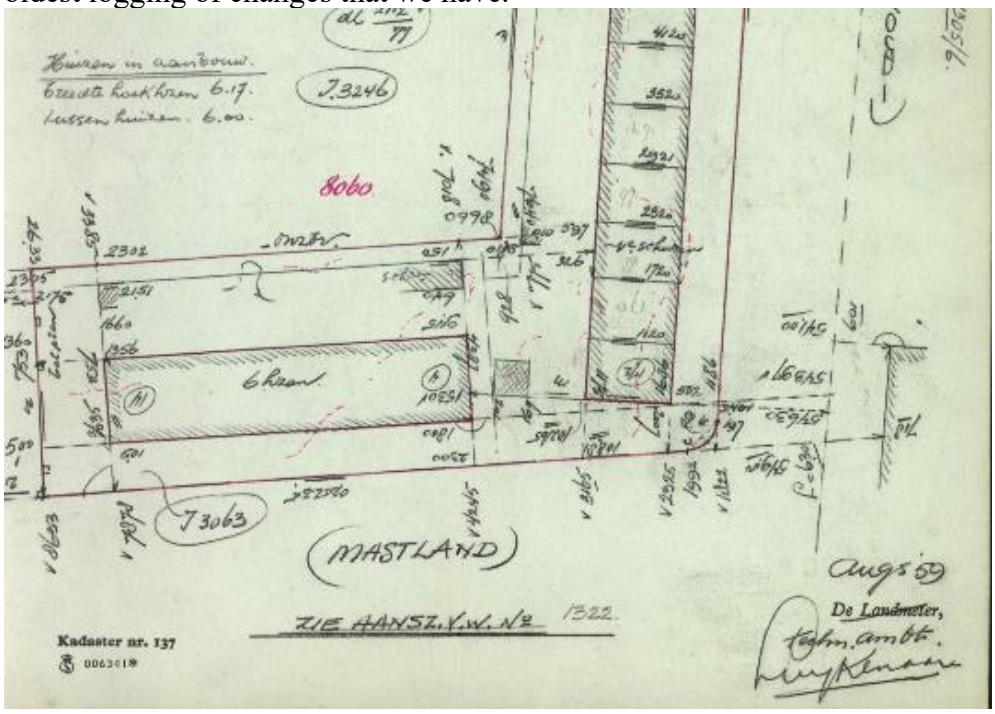

Figure 3: example of a field sketch

It took another full century until the next important milestone was reached. 1975 marked the starting point for the creation of a nationwide large scale topographic basemap. It took until 1989 for this map to be finished, and by then, all cadastral sections could be positioned

according to overlapping buildings on the large scale base map. It still took until the early years in this millennium for a digital, nationwide, cadastral map was completed. By then, all sections still existed but both the map sheets and section boundaries were no longer visually present on the map, a truly integrated map can be presented, with positioning in accordance with the large scale base map.

By the end of the first decennium of this millennium, The Netherlands implemented a system of base registrations, not only for the Kadaster (BRK), but also for large scale base topography (BGT), addresses and buildings (BAG) and numerous others. Finally, in 2016, the cadastral map became open data, and therefore freely available for all users.

3. DIGITIZING LOCAL PARCEL MAPS

After the cadastral map was complete, some ideas arose to digitize the archives as well. This meant scanning of all field sketches and local parcel maps, but also converting at least the parcel maps to vectorized information so they could be used as spatial data. A big project has been launched which took the cadastral map of 2010 as starting point, digitized all parcel maps, and from this information trace back what the cadastral map would have looked like if all parcel map transactions were undone. This task was completed all the way back to 1950, creating a continuous history of a nationwide cadastral map from 1950 until now, even though in reality no such product existed.

A combination of machine learning and outsourcing has been used to create this database, a spatial database known as the Local Parcel Map Database, ("*Hulpkaarten Perceel Database",* HPD). The database contains all parcels that have existed at some point in history, accompanied by the year they were formed and the year they ceased to exist.

Local map	formed	expired	year
GNK02_I01269	9348, 9349	9274	1980

GNK02_I01221	9196, 9197	8060, 8061, 9097	1976

Figure 4: example of parcels in the local parcel map database

The output of the query in figure 4 is generated by selecting a parcel in the current map, using its boundaries to drill down in the history of parcels. Each parcel that has existed on this location at some point in time, will be found and reported. This procedure is known as "*Geographical Filiation*". Filiation is the relationship between expired and new parcels, and vice versa. The accuracy of the history is in years, as at least for older parcels, actualisation of the map was a yearly process. All parcels do get reported though, also if they are formed and expired in the same year.

4. ERRORS IN INTERPRETATION AND CONSEQUENCES

Of course, this database could provide various valuable applications by retrieving all parcels that have existed at some point in history, or by presenting the state of the map at the end of each year in history. A current example is to present all rights of easement that apply to a specific location. But what happens if data is inconsistent with the local parcel map, for example when the data is misinterpreted? In this case, the query will deliver incorrect data, which can have consequences if data is used by notaries determining whether a parcel should be subject to an easement or not. This is the intended use right now, but with errors, we can not guarantee the query returns reliable results. This means we can not use the data in this way. And every query has to be checked manually, which is a very costly task to do.

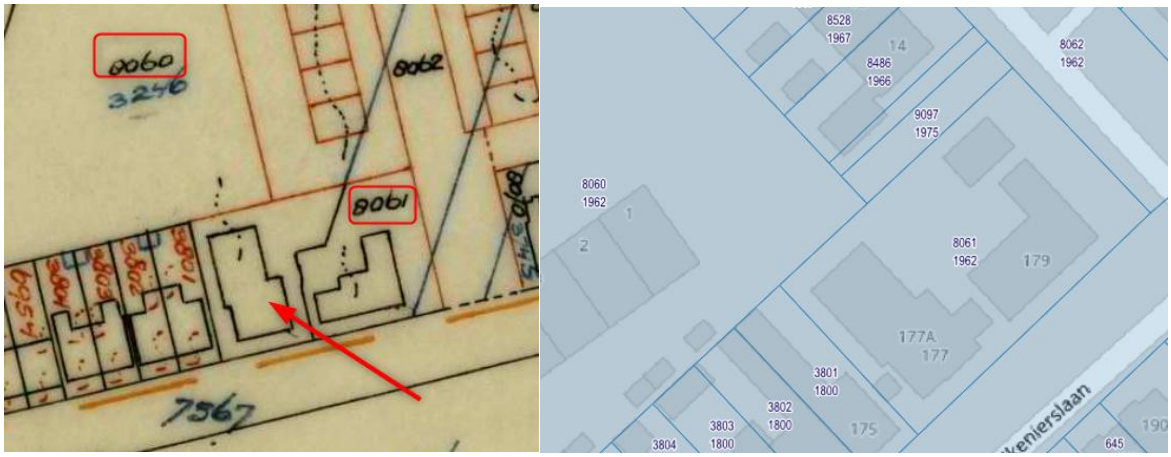

Figure 5: example of local parcel map, the red arrow pointing at a part of parcel 8060, that is misinterpreted to be part of 8061 in the database on the right hand side. The black boundaries of 8061 should have been maintained and 8060 should extend into the now numberless parcel that is pointed out by the red arrow. Now if parcel 8060 is subject to a right of easement, this

will not transport correctly to the parcel that will be created at number 177 on the right hand side of the figure.

5. KKN AND CORRECTION OF HPD

In 2016, Kadaster decided to start a new project, Cadastral Map Next ("*Kadastrale Kaart Next",* KKN), to improve the cadastral map based on measurement data from the earlier mentioned field sketches. In this project, all field sketches are vectorized using AI, measurement data is retrieved from the field sketches, and these sketches are used to calculate an accurate position of all boundaries, using the same adjustment procedures we as Kadaster use to assess the quality of new measurements.

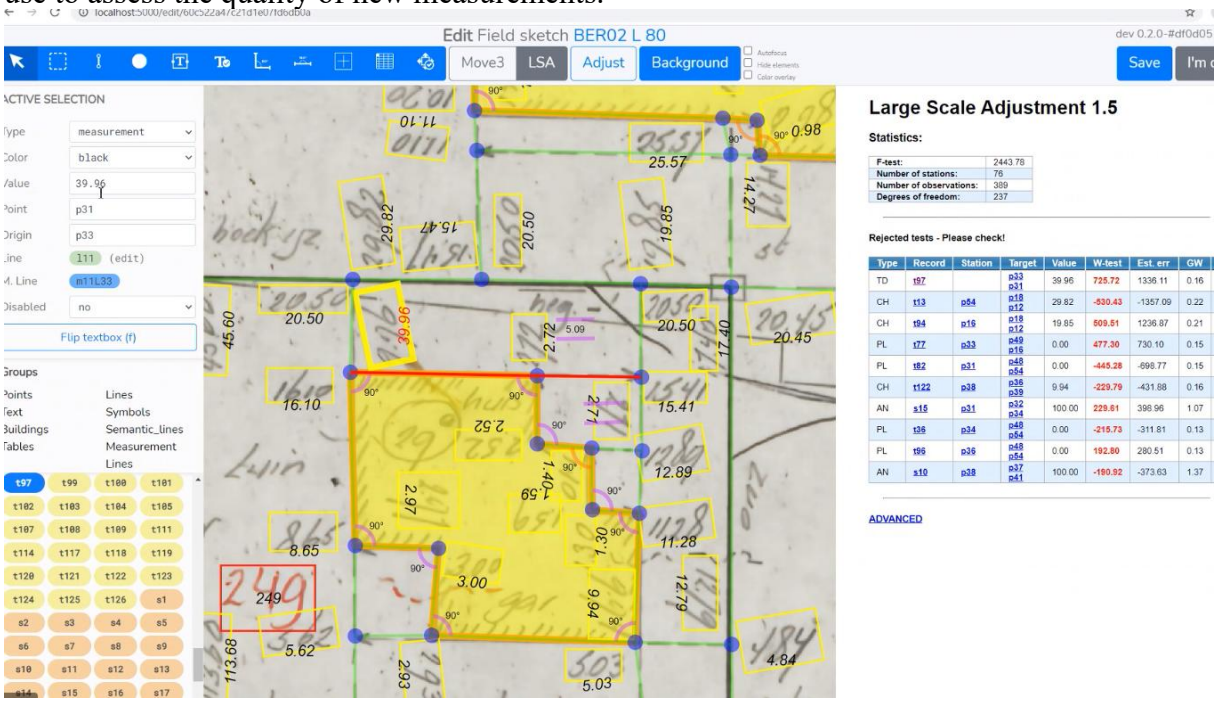

Figure 6: example of a vectorized field sketch with resulting measurement data, which can be subjected to our regular adjustment and testing procedures

The procedure that KKN needs to find relevant field sketches for each current cadastral boundary, uses the data from HPD. Therefore, this project also encountered errors in the HPD, and needed to fix a large number of errors to be able to provide complete information to calculate the new map. This led to a major quality improvement for the HPD.

As can be imagined, not all errors of individual parcel interpretation resulted in problems for KKN. KKN does not fix errors that have no consequences for the calculation of the new map. But other applications, like tracing the right of easements, each error does present a problem.

So to gain even more trust in the HPD data, Kadaster has decided to start an additional project, to fix all known errors in the data.

6. USING END USERS TO CORRECT LAST ERRORS

All quality improvements have led to sufficient trust in the HPD data to involve end users in the process. On Januari 22nd 2025, Kadaster decided to provide access to the Right of Easement Viewer ("*ErfDienstBaarhedenviewer",* EDB viewer) to notaries. In this viewer, notaries get presented whether a right of easement exists on a property, or not, which should be included in a deed if a parcel is sold. The viewer presents the result of geographical filiation, and the local parcel map that the filiation is based upon.

Figure 7: example of EDB-viewer output

The output of the EDB viewer gives the notaries the result of the properties right of easement, but also the opportunity to determine whether the output of the viewer is correct or not. This is important, because the legal certainty of customers depend on it. For notaries and end customers, using the viewer is much cheaper than the manual property right of easement researches were. For Kadaster, the viewer also leads to a big decrease in costs, as the manual research is expensive, but still does not cover the actual costs of the research for us.

The notaries do offer something in return, which is helping Kadaster to improve the data even further. Because notaries have means to discover errors in the database, they can report the errors. This means that Kadaster suddenly has thousands of eyes checking the data, while the data is already in production processes. This means we don't have to look for errors, we just implemented a process to fix reported errors, improving the dataset even more. Do keep in mind this process only became realistic after 2 quality improvement procedures were

completed. If we would have used original data for this, there would be too much errors in the data, end users would grow tired of reporting the errors and trust in the data would be too low.

7. CONCLUDING REMARKS

By vectorizing local parcel maps, improving the quality using AI, and bringing the result to end users of right of easement researches, Kadaster created a valuable database which can present an integral cadastral map throughout our history, decades before such a map actually existed. All kind of cadastral processes could benefit from this, but with one application only, the business case is already sound. We see this as a good example of how AI can help us unlock possibilities we did not have before.

REFERENCES

BIOGRAPHICAL NOTES

CONTACTS

Ir Tom WORTEL
Kadaster
Hofstraat 110, 7311 KZ
Apeldoorn
THE NETHERLANDS
Tel. +31 6 50 16 04 79
Email: tom.wortel@kadaster.nl
Web site: www.kadaster.nl