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Aligning heterogenous topographical data to derive multi-scale content for the Dutch nationwide Spatial Data Infrastructure

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Abstract: The Dutch Kadaster is responsible for the acquisition and maintenance of topographical data and visualisations at scale 1:10k and smaller. This is currently realised through an acquisition process by topographers who acquire 1:10k data from aerial images. In a next step, the smaller scale data and visualisations are derived by a fully automated generalisation process. Now a countrywide large-scale topographical dataset has become available, i.e. the key register large-scale topography (BGT), we have started a project to explore how to derive the Kadaster data from the BGT. This has two main objectives: to save money (i.e. collect once and use data many times) and to make the Kadaster data consistent with the BGT data. In this extended abstract we describe the project in which we define the content of the next generation Kadaster products that will be derived from BGT data.

Keywords: automated generalisation, harmonisation, alignment of data models

1. Introduction

To adhere to the Spatial Data Infrastructure principle "collect once, use many times" automated generalisation processes are needed to efficiently derive data and maps at lower levels of detail (i.e. small-scale) from already collected, large-scale, spatial data. Therefore, in recent years a fully automated generalisation process has been developed by the Dutch Kadaster that automatically generalizes the smaller scale products from the base data at scale 1:10K, called TOP10NL (Stoter et al, 2014a). The TOP10NL (i.e. topographic data at scale 1:10k) is acquired by topographers from aerial images and panorama images. Together, the multi-scale products (both data products and maps) starting from 1:10k form the Base Register Topography (BRT), see Figure 1. Kadaster is responsible for the production and maintenance of the BRT.

Figure 1: the multi-scale products of Kadaster

The BRT is part of the framework of base registers that has been established in the Netherlands (also called "key registers"). In this framework, specific governments are responsible to collect specific data and other governments are obliged to use the data collected by other governmental organisations. At this moment, there are ten Base Registers (Digital Government 2020). Two of these – i.e. the base register large-scale topography (*Basisregistratie Grootschalige Topografie, BGT*) and BRT (for scales 1:10k and smaller) - define multi-scale topographical data about roads, water, land use, bridges, buildings, etc. In addition, information (including geometry) about buildings is not only stored in the BRT and BGT, but also part of the Base Register Addresses and Buildings (BAG). The acquisition of BGT (and BAG data) is the responsibility of many organisations, which are mostly municipalities.

The BRT, BAG and BGT have been developed apart from each other and for different purposes: the BRT has its origin in multi-scale map production and therefore contains many attributes to support symbolisation on a map; BAG and BGT data are meant to support the maintenance of public space by municipalities, provinces, waterboards, etc. and contain attributes needed for this purpose. The differences in the purposes of the data has led to differences in the datasets.

Nowadays, these base registers have matured and the question is how BRT, containing multi-scale products, can be derived automatically from BGT and BAG, starting from TOP10NL. The interest to automatically derive BRT from BGT has two reasons. The first reason is consistency of topographical data provided by different governmental organisations and this requires the harmonization and alignment of BRT, BAG and BGT. The second reason is cost reduction, i.e. to increase the reuse of once collected data and decrease separate acquisition processes of more or less similar data.

For this reason, Kadaster has started a project to define a new product family: BRT.Next. The BRT.Next will be automatically generated from BGT/BAG data, and consequently, will be different than the existing BRT acquired by topographers. These changes are not per se problematic because the BRT specifications are based on map specifications that sometimes were defined decades ago with military use in mind. For example, the width classes of water are based on how far a soldier could jump (3m) or what width could still be taken by a tank (6m). These requirements are not necessarily valid in current reality with no more military activities in the field. In addition, the application of current BRT data - countrywide available since 2008; and before 2008 as vector data underlying the maps - has broadened to more and diverse disciplines. These new users might be served evenly well by BGT data, which has become available countrywide since 2016.

In short, the aim of the project is to reconsider the content of the BRT (starting from TOP10NL) and to define new content for a future proof BRT (called BRT.Next) that has a different context than current BRT: BRT.Next will be automatically derived from BGT and BAG instead of acquired from areal images by topographers; BGT data has become countrywide available and could replace current use of BRT-data which will change the user requirements of BRT-products; and, some BRT-specifications might no longer be valid.

Our previous studies on this topic (Stoter, Altena, et al. 2014b; Stoter et al, 2009a, 2009b; Stoter, 2009) were mainly based on a comparison of *data models*, because of a lack of countrywide BGT data. Our current project also investigates the harmonisation and the generalisation of countrywide BGT *data* that has become available.

2. Differences between source and target data

We have done several studies to identify the relevant differences between BGT and BRT and their impact on aligning the two registers (Stoter et al, 2009a, 2009b; Stoter, 2009; Stoter, 2010). These need to be addressed in our project and are therefore summarised here.

The first prominent difference is scale. BGT is supposed to be at a more detailed scale then BRT. However, in rural areas, where maintaining public space can be done with less accurate data, often the BRT dataset contains more details, see Figure 2.

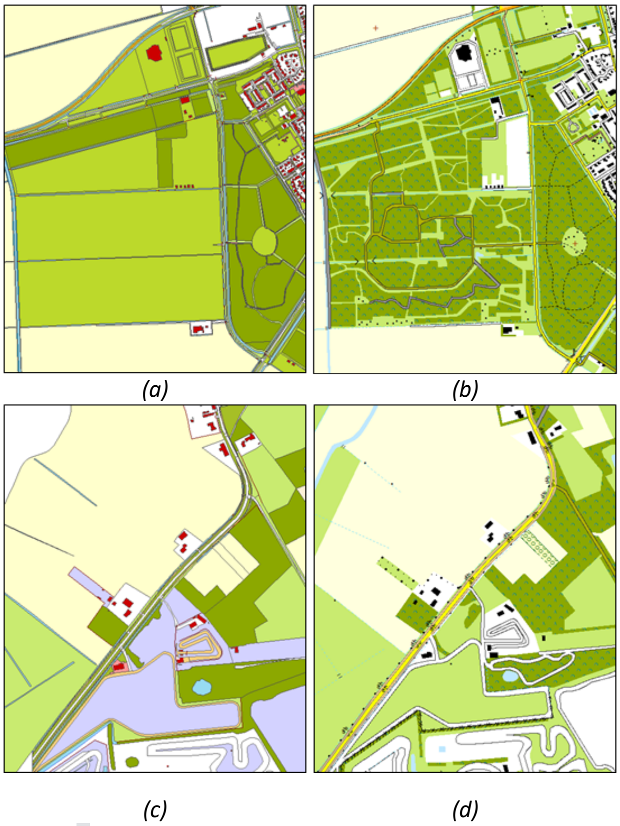

Figure 2 In rural areas BGT on the left (a, c) contains less detailed data than BRT (right: b , d).

Secondly, there are geometrical differences related to scale. Most objects in BGT are polygons, while these are points or lines in the BRT, such as small roads and water ways.

A third difference (as also explained in Dukai et al, 2020) is the way BGT and BRT maintain information on relative heights. Terrain, water and road objects in TOP10NL that are visible from above form a planar partition (i.e. no overlap or gaps); whereas BGT models the planar partition at ground (surface) level. Consequently, in BGT objects can be located above the planar partition (indicated with relativeHeight > 0). In contrast, in TOP10NL no objects can be located above the planar partition: objects with heightlevel=0 are located at ground level (when no other objects are overlapping in the vertical dimensions) or on top of a stack of multiple objects, see Figure 3.

Figure 3: relative height information as available in the BGT. The bridge (H) is at relative height level '1'. The bridge-parts F and G as well as the road, verge and water are at relative height level '0'. The latter form a planar partition (IMGEO 2020)

A fourth difference between BGT and BRT is that there are many concepts in BRT that are not available in BGT. In case these cannot be derived automatically, BGT cannot be used to generate the concepts. Examples are centerlines of roads, crossings of roads, function of buildings, engineering elements, etc.

A fifth difference is that the BRT also contains many more attributes than BGT to be able to apply a rich symbolization in the maps. Examples are additional attributes for the roads: number of lanes, exits, road-widths, etc.

Finally, some objects are stored as separate classes in the BGT, while the BRT stores these as attributes of other classes. Examples are Tunnels and Bridges, both classes in the BGT. These are BRT road segments with physical appearance "on bridge" or "in tunnel".

3. Approach

Our methodology to define the new specifications of BRT.Next is not obvious since the end result of BRT.Next is still open and depends on many interrelated considerations: what BRT data can be automatically derived from BAG and BGT, and how? What are the users' expectations? Which current usages of BRT-data could use BGT instead and what are the remaining use cases for BRT, both for the data and for the maps? What additional information is required to be able to continue the production of small-scale products at Kadaster? What are the minimal requirements of BRT.Next that must be fulfilled? What impact has the quality of BGT-data which is collected by hundreds of organizations resulting in highly heterogenous data across the country?

3.1 Principles

To address this multi-aspect context, the definition of BRT.Next follows the following principles:

(1) Imitating the current TOP10NL (and the other small-scale products) is not the aim. However, to have a target to work to (and compare with) we do use TOP10NL as target data set. This has another advantage: the closer the data is to the current multi-scale data, the more we can reuse the existing automated generalisation process to automatically derive the small-scale products. Any significant change in this process will result in an increase of the costs instead of a reduction of the costs, as is the aim of our project.

(2) The production should be based on as much as automation as possible in order to realise the foreseen cost reduction. Only in exceptional cases acquisition (and maintenance) of additional data should be done by Kadaster

(3) We will use the semantics (i.e. attribute names and values) of BGT as much as possible in order to harmonise both data sets and to provide the user with consistent governmental topographical data.

(4) The BRT.Next data should meet the main and basic user needs. Needs that are specific for one user could eventually be met in an additional product.

(5) BRT.Next should be able to support the current automated production of the small-scale data products. Data requirements of this production line should therefore also be met as much as possible, additional to users' needs.

3.2 Methodology

Our methodology to define the content of BRT.Next consists of the following steps:

1. For different themes (water, roads, buildings, administrative areas, nature), a small study is carried out to identify what TOP10NL data (geometries and attributes) can automatically be derived from BGT/BAG, and how.
2. The semantics of BRT is as much as possible expressed according to the BGT data model (class names, attribute names, attribute values, definition) in order to achieve optimal harmonisation.
3. Step 1 and 2 lead to an initial data model for BRT.Next that is presented to the users for evaluation in a survey. For each original TOP10NL concept the TOP10NL.Next equivalent is mentioned as well as if it could automatically be derived. The users are asked for each concept if the new proposal will affect current processes. The users' survey is supported by use case studies to understand in depth the needs of the users and the impact of the changed data in BRT.Next on these needs.
4. We check whether there are other conditions that we need to fulfil, such as data requirements enforced by law (INSPIRE) and data requirements needed to produce small-scale data and maps.
5. Parallel to this, a study is carried out for each theme on how it is currently available in BGT and how this will impact BRT.Next. The BGT is acquired by almost 400 organisations. We know from previous studies that this results in highly heterogenous BGT data, even if they are all adhering to the same acquisition guidelines. This is also due to the fact that the BGT is very new and therefore there has been no time yet to resolve different

interpretations of the guidelines. However, such differences will affect the results we can achieve. The study is meant to provide insights how current BGT data impacts the result of BRT.Next that will automatically be derived from it.

In future work we will report about the results of each step in which also the connection between individual themes will be addressed.

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