GIMA

Geographical Information Management and Applications

Towards a TOP10NL derived from the BGT: An investigation of the semantic differences and user needs

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Msc Thesis, version 3.1
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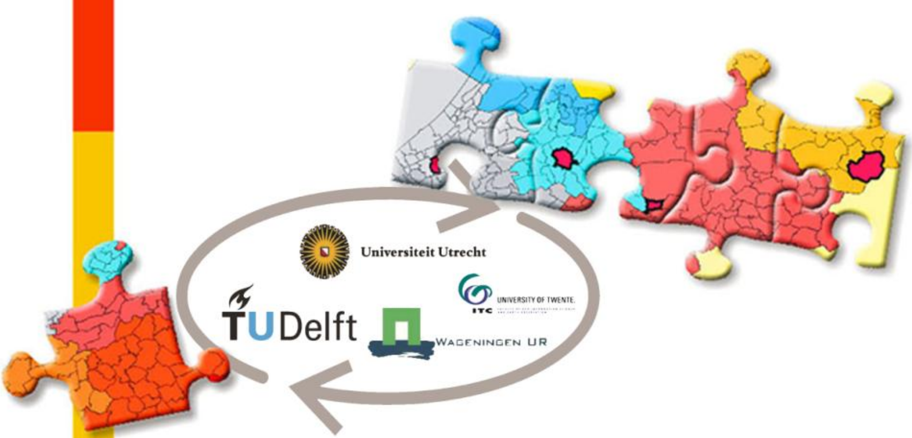

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Foreword

This MSc Thesis is developed to fulfill the requirements of the GIMA master program. The thesis work is performed in cooperation with employees from the Dutch Kadaster. The Kadaster proposed this subject and supported me with this research. This thesis is developed during an internship at the Kadaster in Apeldoorn for eight months. Following this period the report is revised a few times.

The development of the BGT offers opportunities for the development and maintenance of TOP10NL. The Kadaster is interested in the possibilities and consequences when BGT is used to develop and maintain TOP10NL. Therefore they proposed and supported this research. The research offers insights into the differences between BGT and TOP10NL and consult TOP10NL users about importance of TOP10NL information.

I hope that this report gives the reader more insight into this research and into the topic. Hopefully, the presented results of the research will help to eventually establish a link between BGT and TOP10NL.

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Summary

Two separate key registrations for topography exist in the Netherlands. The BGT describes large scale topography and the BRT describes medium to small scale topography. Large scale and medium to small scale topography are surveyed and maintained independently at the moment. TOP10NL is the most detailed product of the BRT. The Kadaster researches the possibilities to use BGT to derive the TOP10NL. Also the consequences for the BRT are researched. In this context the research aims to find the semantic differences between BGT and TOP10NL for users and also if changes in TOP10NL information due to BGT derivation are acceptable for the users. BGT and TOP10NL are compared to find the differences.

The method of this research consists of 3 steps. BGT and TOP10NL are compared in step 1 to get insight into the differences between the products. The comparison focuses on the information models of both products. Users are consulted in step 2 to get their perception regarding modified TOP10NL information. The Dutch law and INSPIRE are also investigated. The INSPIRE requirements are researched to find out which TOP10NL data is used to meet these requirements. Furthermore, two user needs studies of the Kadaster are investigated. Step 3 concludes the research.

Literature shows that each topographic product describes the reality in a unique way. The goal of the product determines which objects of the reality are described and added on the map. Topographic products are developed with different purposes and therefore they differ (Aalders, 2001). This is also valid in the case of BGT and TOP10NL.

BGT and TOP10NL are developed with a different purpose. The purpose of BGT is to assist maintenance of public space, while the purpose of TOP10NL is orientation and visualization. As a result not all information available in TOP10NL is present in the BGT. Information that is included in both models often is different. Due to these semantic differences TOP10NL information will change when BGT becomes the source. The scale difference between both products result in a different representation on the map. Many detailed information that is available in BGT is generalized in TOP10NL.

Users find the geometry and consistency of TOP10NL data are more important than the content of attributes. Real world phenomena should be interpreted and represented in an unambiguous manner. A changed meaning of attributes and attribute values is not preferred. Part of the important information for users and INSPIRE has to be surveyed. An often mentioned suggestion by users is to survey data from multiple sources. The BAG and AHN were mentioned as potential sources. The law allows changes in the content of TOP10NL except the object classes.

The conclusion of the research is that users prioritize a TOP10NL with consistent data and a correct geometry. Likely changes in semantic content due to BGT input are not preferred. An extensive user needs research is necessary to valid this conclusion. Furthermore it is recommended to research other datasets that could be a potential source for TOP10NL and the possibilities of automated generalization.

Samenvatting

In Nederland zijn twee aparte basisregistraties voor topografie ontworpen, de BGT en BRT. BGT voor de grootschalige topografie en BRT voor kleinschalige topografie. Grootschalige en kleinschalige topografische informatie wordt op dit moment onafhankelijk ingewonnen en bijgehouden. TOP10NL is het meest gedetailleerde BRT product. Het Kadaster onderzoekt de mogelijkheden om de BGT te gebruiken om de TOP10NL af te leiden en de consequenties daarvan voor BRT. In deze context is het doel van het onderzoek is het achterhalen van de semantische verschillen tussen BGT en TOP10NL en tevens of veranderingen in informatie als gevolg van afleiding uit BGT geaccepteerd worden door gebruikers. Hiervoor zijn BGT en TOP10NL met elkaar vergeleken om de verschillen te vinden.

De methode van dit onderzoek bestaat uit 3 stappen. In stap 1 zijn BGT en TOP10NL vergeleken zodat de verschillen tussen beide producten inzichtelijk worden. De vergelijking focust zich op de informatie modellen van beide producten. In stap 2 zijn gebruikers benaderd om aan te geven hoe zij denken over wijzigingen in de informatie van TOP10NL. De Nederlandse wet en INSPIRE zijn eveneens geraadpleegd. Verder zijn twee gebruikersonderzoeken van het Kadaster geraadpleegd. Stap 3 concludeert het onderzoek.

In literatuur wordt beschreven dat ieder topografisch product op een unieke manier de werkelijkheid beschrijft. Het doel van het product bepaalt welke onderdelen van de werkelijkheid worden beschreven en toegevoegd worden. Doordat topografische producten met verschillen doelen ontwikkeld worden ontstaan verschillen (Aalders, 2001). Dit is ook het geval tussen TOP10NL en BGT.

BGT als TOP10NL zijn ontwikkeld vanuit een verschillend doel. Het doel van BGT is het ondersteunen van het beheer van de openbare ruimte terwijl het doel van TOP10NL oriëntatie en visualisatie is. Als gevolg daarvan is een deel van de TOP10NL informatie niet in BGT te vinden. Informatie die aanwezig is in beide modellen is vaak verschillend. Door deze semantische verschillen zal TOP10NL informatie anders worden met BGT als bron. Op de kaart is er een verschil in representatie door het schaalverschil. Veel gedetailleerde informatie die aanwezig is in BGT is gegeneraliseerd in TOP10NL.

Uit het gebruikersonderzoek blijkt dat een foutloze geometrie en consistent ingewonnen data belangrijker zijn dan de inhoud en betekenis van attributen. Een veranderde betekenis van attributen en attribuutwaarden is voor de geraadpleegde gebruikers niet gewenst. Een deel van de belangrijke informatie, voor zowel klanten als INSPIRE, moet worden ingewonnen. Een veelgenoemde suggestie van gebruikers is om data te winnen uit meerdere bronnen. De BAG en AHN zijn genoemd als mogelijkheden. De wet laat het toe om TOP10NL te veranderen uitgezonderd de objectklassen.

De conclusie van het onderzoek is dat gebruikers vooral een TOP10NL willen die consistente data en een correcte geometrie bevat. De werkelijkheid moet eenduidig geïnterpreteerd en gerepresenteerd worden. Mogelijke veranderingen in de semantische inhoud als gevolg van BGT input zijn niet gewenst. Vervolg onderzoek moet uitwijzen of deze conclusie ook gelding is als een grotere en diverse groep gebruikers wordt geraadpleegd. Daarnaast wordt ook aanbevolen om onderzoek te doen naar andere geografische producten die een bron kunnen zijn voor TOP10NL en de mogelijkheden van automatische generalisatie.

1 Introduction of the research

1.1 Background

The BRT (key registration topography) became obligatory by law in 2008. It consists of all small scale topographic maps of the Netherlands. TOP10NL is one of the products part of BRT (Stoter, 2009). TOP10NL was developed in 2005 (Bakker et al., 2005). TOP10NL often is associated with a map. However, TOP10NL is a geographic dataset used for visualisation and orientation. This dataset is described in the TOP10NL information model, that consists of catalogs and an UML model. These describe which information is available in TOP10NL and how that is displayed on the map (Kadaster, 2013a). Governmental organizations are obligated to use TOP10NL for their topographic information because it is part of the BRT (Hofman, 2008a).

However, governmental organizations use large scale topographic data for maintenance purposes. Recently a new information model was developed for the large scale topographic dataset. This information model is called IMGeo (Hofman, 2008a). Part of this information model is made obligatory. This part is the key registration large scale topography, called BGT. The IMGeo information model describes the content found in the BGT dataset (figure 1). The aim of BGT is to get a standardized large scale topographic dataset of the Netherlands. The target scale is 1:1000 (Ministry of Infrastructure and environment 2012a, p8). To ensure the standardization it became a key registration (Van Rossem, 2012). The development of BGT data has started in 2013. The non-obligated part of IMGeo is used to extend the BGT data with additional information suited for maintenance purposes. In this research the non obligated part of IMGeo is called "IMGeo+" (Ministry of Infrastructure and environment 2012b, p9). Separate catalogs for BGT and IMGeo+ are available.

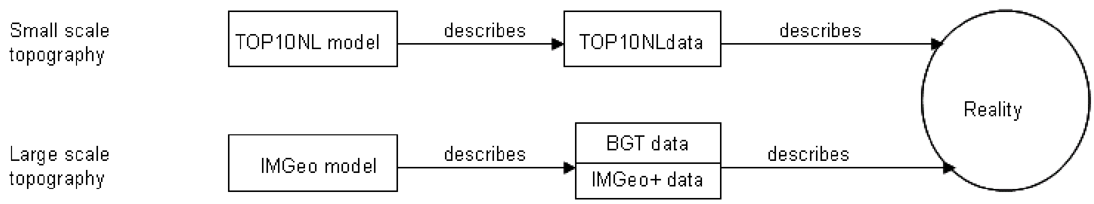


Figure 1: Two different information models are used to describe the reality

Topographic data is surveyed independently for TOP10NL and BGT. The precursor of BGT was not standardized. Therefore this dataset could not be used as source for the TOP10NL data, because TOP10NL should be consistent and standardized for the whole Netherlands. Because BGT is an obligated product for the whole Netherlands, it is an interesting potential source for the TOP10NL. The Dutch Kadaster investigates the possibilities to derive TOP10NL from BGT. The ultimate goal of the Kadaster is to derive the TOP10NL from the BGT using automated generalization.

Automated generalization is a technique to produce small scale data from large scale datasets without human intervention (Van Smaalen, 2003; Stoter, 2009; Peng 1997). Automated derivation of TOP10NL data from BGT will have several benefits. Separate surveying for TOP10NL will be reduced with automated derivation. A similar effect will happen with mutations. With automated generalization, only the large scale data has to be updated. Due to integration of different datasets the small scale map is also updated (Van Smaalen, 2003, p2-3). As a result surveying and mutation costs may decrease. This is of interest to the Kadaster, because the national government confronts the Kadaster with savings.

1.2 Earlier attempts

Earlier attempts were executed to derive small scale topographic data from the large scale topographic data in the past. This has started when digital maps became available. The work of Uitermark (2001) and Van Smaalen (2003) is interesting in the Dutch context. Both tried to link large scale data with small scale data to reduce mutation redundancy and costs.

The goal of Uitermarks' research is to enable update propagation: the reuse of updates in different geographic datasets. In other words, one update is used on multiple maps on different scales. However, this is often not possible due to the differences in data surveying methods and dataset maintenance. Data is surveyed by different organizations for different purposes. Because the purposes of organizations differ, objects in the real world are described differently, resulting in differences in the semantics and the data. As a result it is difficult to link the different datasets (Uitermark, 2001, p1 and 7). According to Aalders (2001) every topographic dataset describes the reality in a unique way.

Uitermark tried to link two different geographic datasets despite the differences between them. He linked the two different data models by building an ontology that described the relations between objects of both maps. These relations are the building blocks to link the information models of GBKN and TOP10vector in the research (Uitermark, 2001). Van Smaalen (2003) developed "inter-object" relationships to enable automated generalization. Recent attempts were performed by Hofman (2008a) and Stoter (2009). They used automated generalization of IMGeo data to derive TOP10NL. Stoter compared in another research the information models of TOP10NL and IMGeo to give suggestions for synchronization (Stoter, 2010).

Differences between data sets do not only occur within the topographic domain. The recognition of the semantic differences of geo data also appears in the research field of web services. It is recognized that interoperability not only depends on web services and common standards. A certain phenomenon often is described differently in different databases. The result is a semantic difference between the databases. In this context several classifications of semantic differences are developed to overcome the found differences and to be able to link different databases (Bishr, 1998, Harvey et al., 1999).

1.3 Goal and objectives of the research

Data for large scale and small scale topography is surveyed and mutated separately at the moment, despite earlier attempts to establish a link. The previous section showed that it is difficult to derive a topographic dataset because data surveying methods differ. The expected savings by the national government are however an impulse to do research about the derivation of TOP10NL from BGT, despite their differences. Three main steps have to be set before TOP10NL can be derived automatically out of BGT (figure 2):

1) The information models of BGT and TOP10NL have to be compared. The comparison shows what information of TOP10NL can also be found in BGT and what information is missing. The comparison also shows the semantic differences. First attempts were made by Stoter (2010) and Lentjes (2012).
2) Research to perform automated generalization from BGT to TOP10NL. This research aims to derive TOP10NL objects out of BGT objects. This covers the geometrical and topological aspects (Hofman, 2008a; Stoter, 2009, Van Altena et al., 2013).

3) Post processing might be necessary to convert the generalized BGT objects into the TOP10NL objects. This depends on the quality of the generalized data compared to the requirements stated in the information model. Information that is not found in BGT, but required for TOP10NL also should be added.

During the process the users should be involved to give feedback about the results and suggestions to improve the result. In this research some users are consulted to give feedback about the found differences between the information models and the importance of TOP10NL information.

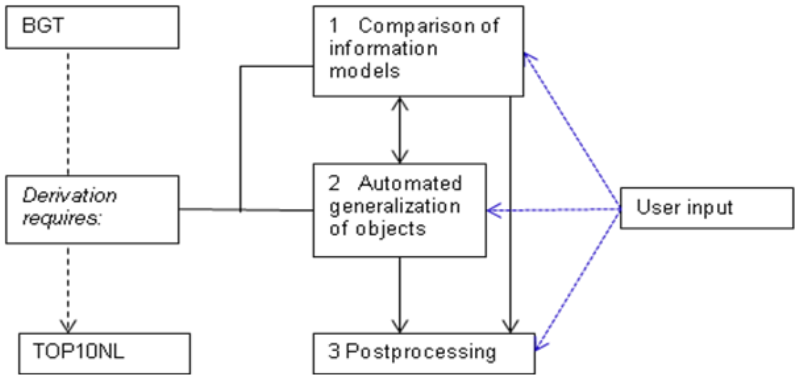


Figure 2: Overview of research steps necessary to derive TOP10NL from BGT

This research will not cover all three topics due to limited time. This thesis focuses on the first box presented in figure 2. User input is also present in this research. Automated generalization is not performed. This is a very technical process that requires a similar amount of research. The Kadaster performed research about automated generalization possibilities at the same time (Van Altena et al., 2013). The post processing part can be done only when the first two steps are done. Following the focus the resulting main research question is:

To what extend can TOP10NL fulfill the user expectations when BGT becomes the source?

To reach the goal of the research two sub questions are distinguished:
1 What are the semantic differences between TOP10NL and BGT?
2 What is the user perception regarding modified information in TOP10NL?

This research is different from other research in several ways. First, it focuses on the information models instead of automated generalization. Therefore the comparison focuses on the semantic differences. Secondly TOP10NL users are consulted to give feedback on the first two models and to get insight about the importance of information in TOP10NL.

1.4 Scope

This thesis research is limited in time. Therefore some interesting related aspects are kept out. Automated generalization is one of these aspects (figure 2). As a result this research does not produce any new datasets. Datasets can be used for a user survey when the research about automated generalization is performed.

Because of the limited time only some key users are consulted. The indications and opinions they give should help to determine how valuable certain information in TOP10NL is. The Kadaster aims to do an extended user assessment after this research and the research about automated generalization.

All topographic maps should be derived from BGT ultimately (Stoter, 2009). Currently research is going on at the Kadaster to harmonize the information models of small scale topographic products, including TOP10NL. The TOP50NL is currently derived from TOP10NL using automated generalization. This research does not focus on the effects of a changed TOP10NL on the information models that describe the maps on other scales.

1.5 Reading Guide

This section gives an overview of the content of the coming chapters. The research method is presented in the next chapter. It shows which steps have been set and how these steps are set. Relevant literature is discussed in chapter 3. Chapter 4 provides an extensive description of BGT and TOP10NL. Chapter 5 provides the results of the first sub question. In this chapter the information models BGT and TOP10NL are compared. The results of the user consultancy are presented in chapter 6. Chapter 7 contains the discussion of the research. Chapter 8 presents the conclusions and recommendations of the research.

2 Research Method

The goal of this chapter is to present and explain the chosen method. A general overview of the method is presented first. Then the steps of the method are discussed in detail. The chapter is finalized with a short reflection.

2.1 Overview of the method

This research is divided in two main steps that belong to the two stated sub questions. Figure 3 presents the sequence and content of the steps. The starting point is the current situation with the two different products TOP10NL and BGT. The steps are further divided in stages. The stages are presented in table 1 and are discussed in detail in the coming sections.

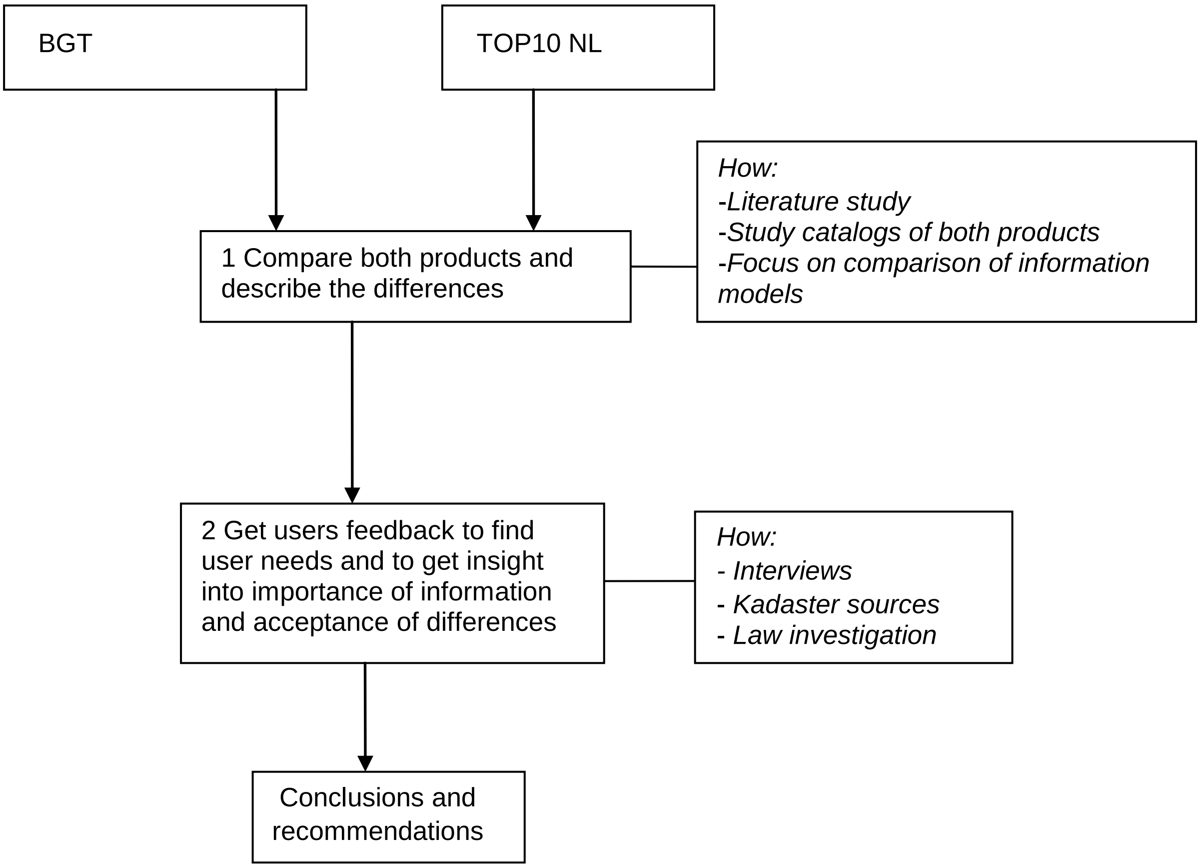


Figure 3: Overview of the research method

The applied methods of the steps are commonly used. They are combined in this research resulting in a unique method. The method of step 1 is based on the work of Stoter (2010), Aalders (2001) and Uitermark (2001). Like Uitermark (2001)relations are laid between two different information models. A difference is that a table is used instead of a scheme due to the amount of attributes and attributes values. Time limitations were an important reason to do a qualitative user input research instead of a quantitative research to collect input from users.

A sequential approach was chosen for this research. This was a logical approach because the results of the first step are necessary input for the user input. The benefit of a sequential approach is that the method is easy to follow.

Table 1: Overview of steps and stages

1	**Compare BGT and TOP10NL**
1.1	Review relevant literature
1.2	Describe current TOP10NL and BGT products
1.3	Compare both information models
1.4	Analyze results of comparison
2	**Get user feedback**
2.1	Investigate Law and INSPIRE requirements
2.2	Investigate key users with interviews
2.3	Investigate Kadaster resources
3	**Conclude and evaluate research**
3.1	Write conclusions per sub objective
3.2	Write main conclusion
3.3	Make suggestions for future research

The coming sections describe the first two steps in detail. The third step covers the finishing part of the research.

2.2 Step 1: The comparison between BGT and TOP10NL

Step 1 is split into four stages. The goal of this step is to get clear insight into the differences and similarities between TOP10NL and BGT. Literature is used to get more insight into the causes and the different types of differences between topographic products. Following the description of BGT and TOP10NL some general elements like the scale and the goal of the products are compared. The research then focuses on the information models and they are compared according to the method of Stoter (2010). The focus lays on the semantic differences, but the geometric differences are not neglected. Examples are used to present geometric differences and how they influences the derivation possibilities. The sequence of stages is shown in figure 4.

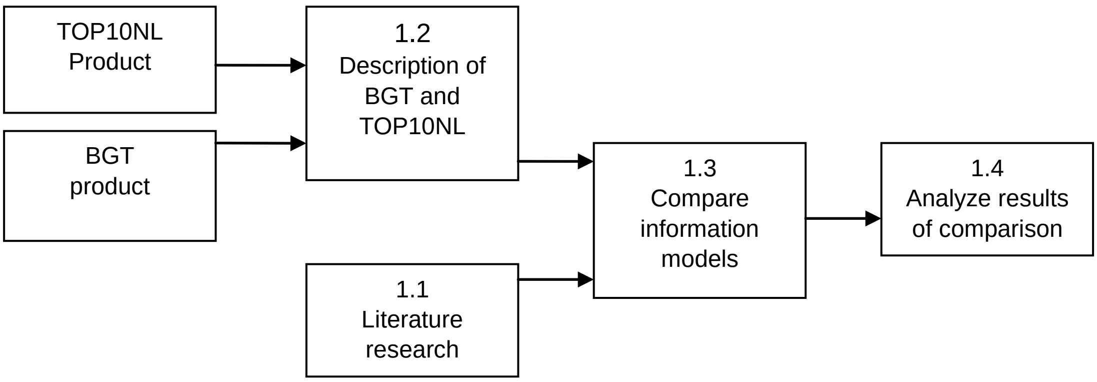


Figure 4: Overview of step 1

The literature research is the first stage. Theoretic insights about different representations of the reality from Aalders (2001) are used to describe and compare the BGT and TOP10NL. Other reviewed literature focuses on possible classification schemes of differences between information models (Bishr, 1998; Von Goesseln and Sester, 2003; Buccella et al., 2009). The result is a theoretical review and an overview of possibilities to classify semantic differences.

Catalogs are available for BGT and TOP10NL. The catalogs describe the products in detail. They describe how the information model is set up for BGT and TOP10NL. They also describe the meaning of all object classes, attributes and attribute values. This information result in a description of the products BGT and TOP10NL. This is done in stage 1.2.

The research then zooms in on the information models of both products in stage 1.3. The information models are compared at the level of object classes, the level of attributes and the level of attribute values in stage 1.3. A comparison table is used. Each TOP10NL element is matched with relevant BGT elements. The following works are used as input for the comparison of the information models:

- the object catalog of BGT (Ministry of Infrastructure and environment, 2012a);
- the BGT object guide (Ministry of Infrastructure and environment, 2012c);
- the TOP10NL object catalog (Kadaster 2013a);
- the TOP10NL surveying rules (Kadaster, 2011).

The comparison gives an indication of the possibility that a TOP10NL attribute or attribute value can be derived from a BGT attribute or attribute value. The comparison is only performed at the semantic level. The geometric aspects are not taken into account. Therefore the comparison results only in an indication of the possibilities to derive a certain TOP10NL attribute from a certain BGT attribute. The comparison is performed manually. Several researchers have done a similar comparison manually (Stoter, 2010, Erikson and Skanes, 2010; Jespen and Levin, 2013). Furthermore the semantic differences are found.

In stage 1.4 the results of step 1.3 are discussed and reflected with some examples that show that geometric differences have also influence on the possibility to derive TOP10NL information from BGT. The examples present some parts of the map and show some geometric differences from BGT and TOP10NL.

2.3 Step 2: Feedback from the users

The results of the first step are used in step 2 where a few key users are asked to give feedback (Figure 5). The law also is investigated. The law is relevant because TOP10NL is part of BRT and this key registration is anchored in law (Ministry of infrastructure, 2007). INSPIRE requirements are also reviewed. Data of TOP10NL is also used for INSPIRE. Information required for INSPIRE should be kept in the TOP10NL information model. This is the content of stage 2.1.

A user needs study is often an essential part of a study. A user consultation is often performed to find the demands that users have. User consultations are performed in different types of research and the method that is used to perform the user consultation is also different. Methods like interviews, surveys and observation are all used in these kinds of studies (Petch and Reeve, 1999, p52-53).

A qualitative method was chosen for the user consultation. The goal of this consultation is to have some in-depth discussions with a few key users to get insight in the consequences of a changed TOP10NL for their usage. Interviews were seen as the best method to find important users needs in a short amount of time. The interviews gave the possibility to go into the details and to talk not only on a global level about the TOP10NL, but also at the level of attributes and attribute values.

TOP10NL users are found in many organizations including the Kadaster. Inside the Kadaster the Autogen team uses TOP10NL to develop the TOP50NL. A changed TOP10NL will have influence on the production of TOP50NL. Therefore this user is interviewed. External users consulted are the Statistical office Netherlands (CBS), research organization Alterra and the IPO (Interprovincial Consultation). The goal of the user consultation is to find out their needs. How acceptable are changes in TOP10NL information? What TOP10NL information is important? Answers to these questions are the goal of the user consultation. The acceptance of the found differences and the need for information depends on the usage of TOP10NL. A visualization purpose requires different information than an analysis purpose.

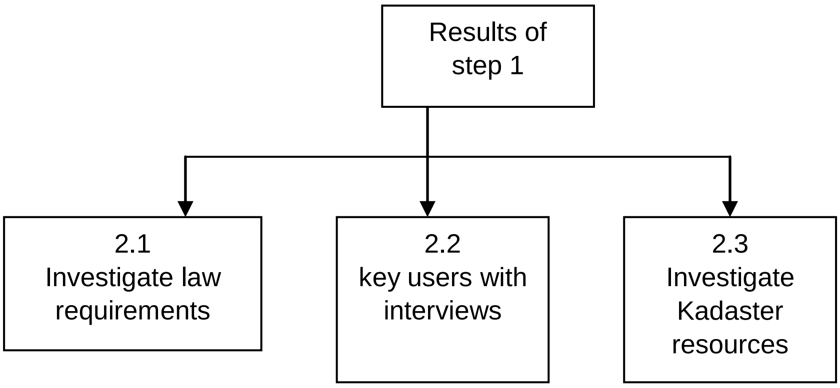


Figure 5: Overview of step 2

The user feedback is gathered by interviews at the location of the users. A study of Stoter (2013) is used to find the needs of CBS. Relevant persons were approached via the Kadaster. One representative of each user is interviewed. The gathered feedback of the users is the result of stage 2.2.

Furthermore, results of a survey and a workshop organized by the Kadaster are also available. The survey asked users to evaluate the content and quality of TOP10NL data. Users also mentioned the most important data of TOP10NL. The internal workshop was organized to evaluate TOP10NL. These sources are studied in stage 2.3. Using the input from the Kadaster workshop and survey besides the interviews fits the approach of Börjeson et al., (2006). These authors mentioned several methods to get feedback for developed models including a survey and a workshop.

Step 2 gives insight about the preferences from users. The results show which TOP10NL aspects are important and how acceptable it is to change information in TOP10NL. The law and INSPIRE requirements are also known.

2.4 Reflection of the method

The comparison of BGT and TOP10NL in step one focuses on the information models of BGT and TOP10NL. The benefit of this approach is that the semantic differences between the information models are found and described. The found differences give insight into the possible consequences for TOP10NL when BGT becomes the source. A drawback of the used method is the inability to state conclusions about derivation possibilities. Comparing the information models is not sufficient to make statements about TOP10NL objects that can be derived from BGT, because automated generalization possibilities are not researched. Separate research is necessary to make conclusions about automated generalization possibilities.

A qualitative method is chosen for the user needs research. The benefit of this method is that the consultation of users leads to some interesting discussion regarding the importance of

TOP10NL for the users. Different aspects of TOP10NL were discussed. The interviews allowed talking "in-depth" about TOP10NL and to ask users about the importance of individual attributes and attribute values. A drawback of the chosen method is that only a few key users are consulted and that the conclusions of this user consultation are probably not representative for all TOP10NL users. If different TOP10NL users were consulted then the outcomes could have been different.

3 Relevant literature for the research

This chapter reviews some scientific literature relevant for this topic. The goal is to get more understanding why differences occur between topographic products and eventual possibilities to solve these differences.

3.1 Universe of Discourse

Section 1.2 already presented a small overview of relevant literature. Some earlier attempts to link different topographic products have been presented (Uitermark, 2001;). Uitermark faced the problem that different topographic products offer different representations of reality. The reality is often too complex to describe completely on a map. Especially on a small scale map many things are generalized to get an understandable map. Therefore different representations of the reality are presented in different topographic products (Aalders, 2001; Uitermark, p7).

The fact that each map is an abstraction of the reality designed with a certain purpose is called *"Universe of Discourse"* (Aalders, 2001). The content of a geographic database is dependent to the purpose of that database. Based on that purpose an information model is determined that describes the content that should be in the database of the product. Each geographic database has an Universe of Discourse that includes the information model, the reference system and the surveying rules. Surveying rules are selection criteria that determine which real world objects are present in the database. As a result each topographic product is a unique and limited representation of the reality. Therefore it is not surprising that differences occur when comparing topographic products (Aalders, 2001).

The differences between topographic models make it difficult to link them and apply automated generalization. Still several researchers did an attempt to link two topographic products. The work of Uitermark (2001) is an example. The approach that is developed tries to link geographic datasets despite the differences between these datasets. Uitermark (2001) used the concepts of object classes and hierarchies (Molenaar, 1998). Using the hierarchy of object classes Uitermark was able to connect the objects of two different topographic datasets. These datasets have objects with different attributes.

3.2 Classifications of differences

Several studies have been conducted to find out the differences that can occur when linking information models. Differences occur because each information model describes the reality in a different approach. One of these studies is from Bishr (1998). Constraints must be solved to be able to share information. One of these constraints is on the semantic level. On this level the focus lays on the different interpretations and meanings of terms (Bishr, 1998). The term "semantics" means the study of meaning (Brodeur, 2012, p589). The meaning of similar looking objects on a map may differ due to different purposes of datasets. (Uitermark, 2001, p7; Harvey et al., 1999).

The difference of the meaning of a certain object is seen by Bishr as one type of heterogeneity. The term "heterogeneity" is used in this context to make clear that objects in different information models are different, although they model the same real word object. Semantic heterogeneity is one of the classified differences that can occur and is described as difference in meaning, description or name for the same objects. The last category is also called naming heterogeneity. The others belong to cognitive heterogeneity in which the definition is different (Bishr, 1998).

Beside semantic heterogeneity Bishr distinguishes schematic and syntactic heterogeneity. Syntactic heterogeneity is described as a difference in representation, for instance a raster representation versus a vector representation. Schematic heterogeneity covers differences in hierarchy and classifications. These differences can occur on the level of objects, but also on the level of attributes. Schematic heterogeneity is a different representation of equivalent data, due to different units or different classifications, different attributes or different attribute values (Bishr, 1998).

This division by Bishr is used by Gomez-Perez et al. (2008), but the authors also mention another classification. In this classification the semantic and schematic differences are not different from the description by Bishr, but conceptual and spatial differences are also added. The spatial differences focus on the representation. For instance a road is displayed as a line in dataset A, while in map B the road is a polygon. This is a spatial difference. A conceptual difference occurs when a feature is an object in database A, while being a relation in database B (Gomez-Perez et al., 2008). The same classification scheme is found in Bucella et al. (2009).

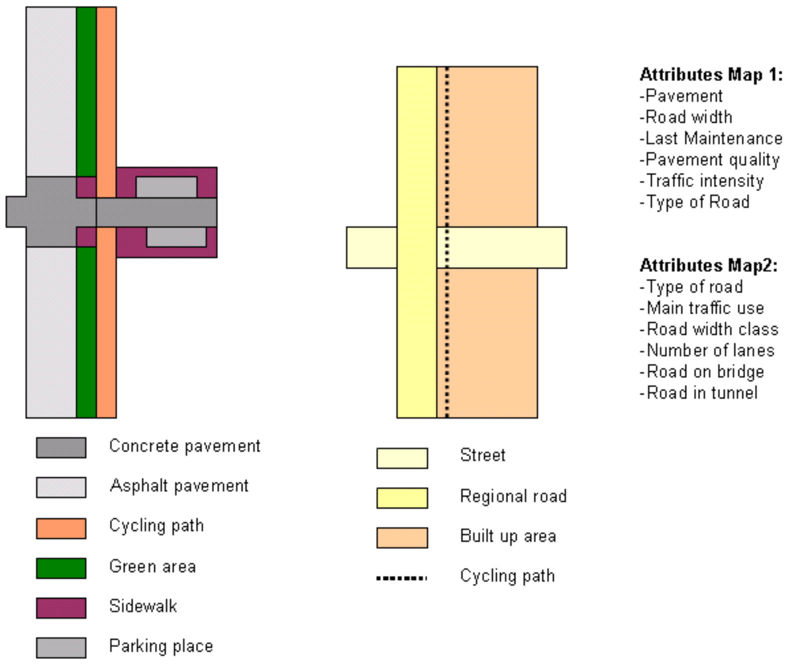
An almost similar classification scheme is proposed by Brodeur (2012, p594). Four different types of heterogeneity are distinguished. These are semantic, system, syntactic and structural. Structural differences are differences in modeling, like differences in geometry or properties. This is comparable to Bishrs schematic heterogeneity except for the geometry differences that are not mentioned in the division of Bishr.

Table 2: Overview of different classifications of differences between geo data information models

Bishr (1998)	**Bucella et al. (2009)**	**Delgado et al (2013)**	**Brodeur (2012)**
1 Semantic	1 Conceptual model	1 Terminological	1 System
1a Cognitive	2 Spatial model	2 Syntactic	2 Semantic
1b Naming	3 Structure or schema	3 Conceptual	3 Structural
2 Schematic	4 Semantic		4 Syntactic
3 Syntactic			

Delgado et al. (2013) distinguishes three different sources of heterogeneity. Terminological refers to a difference in name. Syntactic refers to a difference in structure, language and relationships. For instance, two similar sub classes belonging to different super classes. Finally, conceptual differences deal with differences in purpose and level of detail.

The proposed ways to classify differences are not much different, but different terms are used and the definitions also show small differences. It is similar to the problem of two different datasets that describe the same objects, but do it in a different way. Table 2 shows that a standardized approach to classify differences does not exist. The classification proposed by Bishr (1998) is usable for this research, because several types of heterogeneity are clearly distinguished. The classification distinguishes name differences and semantic differences. The distinction of schematic differences is useful because it covers different between equivalent data that are not semantic, but appear due to different classifications in the information models. These kind of differences are probably found during the comparison of the information models.



Dataset 1: Road maintenance **Dataset 2: topographic map**

Figure 6: *Example how datasets with different purposes model roads differently*

An important cause of differences between datasets is the different purpose with which databases are developed. The purpose influences the content of the data, the meaning of terms used and the visualization (Uitermark, 2001, p7). By using an example the problem is made clearer. A road can be mapped in different ways depending on the purpose. In Figure 6, the purpose of dataset 1 is to use a road map to support road maintenance. Thus the roads are classified according to the pavement types and have been giving attributes that are related with road maintenance, such as last maintenances and pavement quality. To maintain the roads efficiently all details are included on this large scale map such as parking spaces. The real surfaces can easily be calculated using this map. The map can also be used to maintain the green area between the road and the cycle path.

On the other hand dataset 2 is used as a topographic map for visualization purposes. The roads are classified according to their function in the road network. The roads have attributes to specify their function and some attributes to distinguish bridges and tunnels. The cycling path is modeled as a line. The surroundings of the roads are generalized and added to the Built up area class. For the topographic map only the location of cycling paths are important, and not the exact width. If the information of model 1 is used to derive model 2 then problems may appear. The geometry of the roads does not match. Due to the different purposes the attributes also do not match and important information for model two is missing. Linking these models is difficult because of the different purposes. Other similar examples are found in Harvey et al. (1999).

4 Description of BGT and TOP10NL

This chapter describes the BGT and TOP10NL. The description covers aspects of these products.

4.1 The BGT

The BGT (basic registration topography) is developed with the purpose to have a standardized dataset of large scale topography of the Netherlands. The BGT is the successor of the GBKN (Grootschalige basiskaart topografie). All Dutch municipalities use GBKN, but each municipality has its own surveying rules and purposes. Thus the quality and the amount of the data can differ a lot per municipality (Hofman, 2008b p5). The data can be used efficiently for local applications, but for regional applications is the data less workable due to differences in accuracy and content (Peersman and Dijkstra, 2012).

For these reasons it is decided to develop a new topographic information model: IMGeo. IMGeo describes the standardized dataset for large scale topography. The purpose of IMGeo is to standardize and enable the exchange of object oriented geo information at the large scale. All organizations that survey, maintain, use and share large scale topography have standardized data (Stoter, 2009; Hofman, 2008a, p7). IMGeo is based on the Dutch national standard for geo-information NEN3610. This standard is developed with the aim to have standardized definitions for object classes in the geo information domain (Stoter, 2009).

The data that is described in the IMGeo information model is divided in an obligatory and an optional part. The obligatory part of IMGeo is the BGT. It should be possible to survey BGT data once and use it multiple times. This is a quality requirement for all Dutch key registrations (Hofman, 2008a p7). Another aspect of a Dutch key registration is the obligated use for all Dutch government organizations (Ministry of Infrastructure and environment, 2012a, p8-9). The main purpose of the BGT is to help organizations maintaining the public space. The information model of BGT contains detailed information about the public space. Road parts, water parts and auxiliary road and water parts are modeled very detailed. The selected object classes are a result of integration with CityGML. This enables an optional 3D extension (Ministry of infrastructure and environment, 2012b, p15). BGT is mainly collected using terrestrial measurements (Stoter, 2009). In Appendix 1 the UML model of BGT is presented.

The BGT consists of an abstraction of visible objects found in space. These objects are modeled on a scale 1:1000, although the dataset can be used on the scale range 1:500 until 1:5000. The model covers the whole area of the Kingdom of the Netherlands except the Caribbean possessions and the North Sea area (Ministry of Infrastructure and environment, 2012a, p10). The model is built up as a planar graph. The planar graph is formed by all objects on the ground level. It is not allowed to have holes or overlap in the planer graph (Hofman et al., 2008). Objects that lay above or under the ground level are not part of the planar graph.

BGT data is currently in development. The first municipalities are ready with a first version. At the Kadaster two sample datasets were available. These samples showed that the quality of the data is not yet good enough. Differences have appeared between the description in the information model and the data, but also between the two sample datasets. Some of the differences were the result of errors in the geometry and topology. Sometimes similar objects are classified differently in both files. The Kadaster used these files to do some automated generalization tests (Van Altena et al., 2013). The tests resulted in some interesting conclusions about the possibilities to derive TOP10NL data from BGT. One of the conclusions stated is that the data is not yet of sufficient quality and consistency. These are not only the result of the found errors but also due to different interpretations of the municipalities, who created these samples. The information model in its current shape may result in different interpretations (Van Altena et al., 2013).

The risk of different interpretations is high, because BGT is developed by more than 400 different organizations. These organizations include all municipalities, the provinces and the water boards (Ministry of Infrastructure and environment, 2012a, p13). As a result, the consistency of the data may be low due to all different interpretations. Consistency of the data is important to make automated generalization possible (Van Altena et al., 2013).

4.2 The TOP10NL

The goal of TOP10NL is to be an object oriented semantic description of the terrain according to national and international standards (Kadaster 2013a, p4). Data of TOP10NL is mainly collected using aerial photographs that are supported with some terrestrial measurements (Stoter, 2009).

The TOP10NL product is mainly used to for visualization and orientation purposes (Stoter, 2009). The objects classes of TOP10NL cover various topic, like the terrain types, road information, height information and administrative areas. TOP10NL maps objects on the scale of 1:10000. The scale range of the data lies between 1:5000 and 1:25000. As a result, many small real world objects are generalized or neglected. TOP10NL has an extensive guide of surveying rules (Kadaster, 2011). TOP10NL can be used as a background map or for various GIS and web applications. TOP10NL is also used to derive to TOP50NL using automated generalization. It is also the base to produce the other small scale topographic maps. The Kadaster is source holder of TOP10NL (Kadaster 2013a, p4).

During the development of TOP10NL many thematic attributes were added to the information model. Some attributes are made obligatory. The obligatory attributes consist of the attributes that describes general properties, like identity, source and actuality. Other important attributes are the “type” attributes that characterize the objects.

Obligatory attributes have to be filled in the database. Most attributes are optional and do not have to be filled in the database. Sometimes it is impossible to completely fill an attribute. The attribute “fysiek voorkomen” indicates that an object has a relation with an engineering construction. However not all objects have such a relation. In that case the attribute is left empty. Other optional attributes describe additional properties of objects for instance the height or an administrative number (Kadaster, 2013a, p22-24). The UML scheme in appendix 2 presents the object classes and attributes.

Several attributes contain a list of attribute values. The attribute values specify the different values an attribute can have. For example, the attribute values of the attribute “Type Weg” specify the different road types that are distinguished. Many attribute values were added to the information model during the development of TOP10NL. However it was not possible to survey and add all added values in the database. At the moment, still some attribute values exist that are not filled completely in the database according to the surveying rules (Te Winkel, 2013; Kadaster, 2011).

Three categories are distinguished in the TOP10NL catalog. These categories give an indication of the completeness of an attribute value in the database (Kadaster, 2013a):

- Full fill;
- Limited fill;
- No fill.

The classification is applied for attribute values, and also some attributes that do not contain any attribute values. The classification "full fill" means that 95% of the objects are present in the database. Partly filled objects are present for at least 30%. None filled are completely absent in the database or present less than 30% (Kadaster, 2013a). As a result the database of TOP10NL currently contains fewer objects than described in the information model. It is planned to complete the partly filled values when the database is updated. Priorities to survey certain missing values do not exist. Some values that have not been surveyed at all may be removed in an update of the information model (Te Winkel, 2013). The current status of attribute values regarding completeness is found in the TOP10NL catalog (Kadaster, 2013a).

5 The comparison between BGT and TOP10NL

This chapter presents the results of the comparison between BGT and TOP10NL. These are the results of step 1. The background of the differences is discussed first. The second part presents the differences. Three levels are distinguished: the level of object classes, the level of attribute names and the level of attribute values. Some examples of geometric differences are presented in section 5.3 to show that they are an important factor regarding the possibilities to derive TOP10NL from BGT.

5.1 Background of the differences

TOP10NL and BGT were described in chapter 4. They are compared in this chapter. Table 3 presents clear differences between BGT and TOP10NL. The main reason of the found differences is caused by the difference in purpose. The provided information is influenced by the purpose. The purpose of BGT is to support management of public spaces and roads. TOP10NL is used for a much broader audience and comes with more attributes that are mainly used for visualization and orientation (Stoter, 2009).

Table 3: Comparison of some characteristics of BGT and TOP10NL

	TOP10NL	BGT
Purpose	Visualization	support management of public space and roads
Main Source	Aerial photographs	Terrestrial measurement
Scale	1:10000	1:500 to 1:5000
Partition	Formed by terrain, water and roads	Formed by roads, water, terrain and buildings
Height modeling	Top view	Ground level
Provider	Kadaster	Several governmental organizations

Source: Stoter (2009, 2010)

The purpose is especially important when determining the content of the databases. Different purposes lead to different information in the information model (Aalders, 2001). An example is the description of forest in BGT compared to TOP10NL. In TOP10NL five different types of forest are distinguished, while BGT distinguishes three forest types. The specified forest types of TOP10NL find their origin in the military purpose that lay behind the development of the original topographic map. Because BGT is developed to assist in public space maintenance, it contains less different types of forest. This is a schematic difference (Bishr, 1998) between BGT and TOP10NL.

BGT however contains more detail in road pavement types. BGT distinguishes four types while TOP10NL distinguishes three types. Even more types are distinguished in IMGeo+. This fits the purpose of BGT to assist road maintenance. Road pavement types are less important for the TOP10NL and therefore less types are distinguished.

Another important difference between BGT and TOP10NL is the different application of the relative height attribute. Both models are a 2D topographic model. Therefore it is necessary to distinguish a relative height between objects that lay above each other. BGT aims to model the ground. All objects that are modeled on this height get the value "0". Objects that are not on the ground level (for instance in case of a bridge) get a different value that indicates that the object lies above or under the ground. Thus objects on a bridge will get "1" or higher as value for the attribute relative height level. Tunnels lay lower than the ground and get a negative value (Ministry of Infrastructure, 2012a, p14 and 17). TOP10NL models objects from above, giving the highest object the value "0". Objects lying under a bridge get a negative value for relative height, indicating that this object is not the highest object. The different meaning of relative height between TOP10NL and BGT is a semantic difference (Bishr, 1998).

5.2 The comparison of the information models of BGT and TOP10NL

The purpose of a dataset is a main cause for the differences that exist between TOP10NL and BGT. As a result, both have different object classes, attributes and attribute values in the information model. The information models describe the databases of both products. It describes the object classes to which an object belongs to and the attributes and attribute values that an object can have. Differences may also occur between similar attributes and attribute values. The goal of this section is to present the found differences between the information model of BGT and the information model of TOP10NL.

Several sources describe the information models of BGT and TOP10NL. All these sources are used for the comparison. The used sources are:

- the object catalog of BGT (Ministry of Infrastructure and environment, 2012a);
- the BGT object guide (Ministry of Infrastructure and environment, 2012c);
- the TOP10NL object catalog (Kadaster 2013a);
- the TOP10NL surveying rules (Kadaster, 2011).

The comparison is presented top down starting with the object classes. Then the differences on the attribute name level are presented and finally the attribute value level is presented.

5.2.1 The comparison of the object classes

Object classes are compared on their name, definition and geometry. Furthermore, relations are laid between TOP10NL object classes and BGT object classes. The relations give insight with BGT object classes are required to potentially derive a TOP10NL object class.

Table 4 shows the comparison between the object classes of TOP10NL of BGT. For each TOP10NL object class the related BGT object classes are presented. The third column explains geometric operations that are required between each BGT and TOP10NL object class.

Although BGT and TOP10NL have some object classes in common there are differences between these object classes. The object class "Wegdeel" exists in both products. The aim of the object class is to represent the roads in the database and on the map. However the representation differs. In BGT the road part only represent the (un)paved road designed for traffic purposes. Auxiliary road parts like verges belong to another object class and are separate objects. In TOP10NL however, the object that represents a road often represents the road including the auxiliary road parts. This is necessary due to smaller scale to make the map readable. Therefore, even when two attributes are semantically equal a difference may occur due to the difference in representation. Several examples of different representations between BGT and TOP10NL are given in the next section.

Table 4 shows that almost all TOP10NL object classes have a relation with multiple BGT object classes. This is caused by the fact that some BGT object classes are part of an attribute in TOP10NL, for instance "overbruggingsdeel" and "tunneldeel". Other BGT object classes are merged into TOP10NL object classes. "Kunstwerkdeel" and "scheiding" are merged into "Inrichtingselement". Finally BGT object classes can be split over multiple TOP10NL object classes. The BGT object class "Overig Bouwwerk" is split into TOP10NL "inrichtingselement" and "Gebouw".

Table 4: Object classes of BGT and TOP10NL and their relations

TOP10NL Object class	Related BGT object classes	Remark
Wegdeel	Wegdeel	BGT wegdeel objects may be generalized to get TOP10NL polygon and line objects.
	Ondersteunend wegdeel	A part of BGT ondersteunend wegdeel objects may be collapsed and other objects may be merged with BGT wegdeel. The gaps may be assigned sometimes to the Wegdeel objects.
	Tunneldeel	BGT Wegdeel objects may be overlaid with overbruggingsdeel and tunneldeel to derive the TOP10NL attribute “fysiek voorkomen”
	Overbruggingsdeel	
Spoor	Spoor	BGT Railway objects may be generalized to get TOP10NL objects
	Overbruggingsdeel	BGT Spoor objects may be overlaid with overbruggingsdeel and tunneldeel to derive the TOP10NL attribute “fysiek voorkomen”
	Tunneldeel	
Waterdeel	Waterdeel	BGT waterdeel objects may be generalized to get TOP10NL objects
	Ondersteunend waterdeel	BGT ondersteunend waterdeel objects often may be merged with BGT waterdeel objects
	Overbruggingsdeel	BGT Waterdeel objects may be overlaid with overbruggingsdeel to derive the TOP10NL attribute “fysiek voorkomen”
Terrein	Onbegroeid terrein	TOP10NL objects are derived by merging and generalizing the objects from both BGT terrain classes,
	Begroeid terrein	
	Ondersteunend wegdeel	BGT ondersteunend wegdeel object may be collapsed. The gap may be filled sometimes with TOP10NL terrain objects. Sometimes the objects may be merged with TOP10NL terrain objects.
	Wegdeel	Some small BGT wegdeel objects may be collapsed. The resulting gap may be assigned to the TOP10NL terrein class
	Ondersteunend waterdeel	BGT ondersteunend waterdeel object may be collapsed The gap may be assigned sometimes to the TOP10NL terrain class
Gebouw	Pand	TOP10NL objects may be derived by generalizing the BGT objects of Pand. Some objects of Overig Bouwwerk are added to this object class, for instance storage tanks
	Overig bouwwerk	
Inrichtingselement	Kunstwerkdeel	Some TOP10NL objects may be derived. They are found in the four mentioned BGT object classes. Examples are hedges (Begroeid terrain), walls (Scheiding), wind turbines (Overig Bouwwerk) and pumping stations (Kunstwerkdeel).
	Scheiding	
	Overig Bouwwerk	
	Begroeid terrein	
Relief	Scheiding	Noise barriers may be derived from Scheiding, barriers and dikes may be derived from BGT functioneel gebied.
	Functioneel Gebied	
	Wegdeel	Slopes may be derived from the two BGT terrein object classes and the BGT wegdeel en ondersteunend wegdeel object classes
	Ondersteunend wegdeel	
	Begroeid Terrein	
	Onbegroeid terrein	
Functioneel gebied	Functioneel gebied	TOP10NL functional area objects are not included in BGT. BGT has a similar object class for a different functional area.
Registratief gebied	-	Related objects are not included in BGT
Geografisch gebied	Begroeid terreindeel	Some objects may be derived using GIS operations from BGT begroeid terreindeel

These insights are valuable to make a conversion process in which the BGT object classes is converted into the TOP10NL object classes. BGT object classes often have to be split and objects of different BGT object classes are merged into a TOP10NL object classes. The attribute values of the type attribute determines to which TOP10NL object class objects are added. An example is that all buildings that belong to "overig bouwwerk" with the attribute value "storage tank (opslagtank)" are merged into the object class "gebouw", while objects with the attribute value "windturbine" are merged to the TOP10NL object class "Inrichtingselement".

5.2.2 The semantic differences found on the attribute name level

Three factors are considered during the comparison of TOP10NL attributes with BGT attributes. First, the meaning of the attributes is compared. The names of the attributes are compared secondly. The attribute values of a TOP10NL attribute are the third factor that is considered. If they change then the attribute will also change. These factors determine the similarity between TOP10NL and BGT content. The comparison of attributes is found in the table in appendix A3. Fragments of this table are added in this chapter as examples.

Each TOP10NL attribute is matched with an equivalent BGT attribute. Both name and definition are compared. This results in a code that gives the result of the comparison. Each individual comparison result is also given a color that indicates if there is a potential possibility to derive the TOP10NL attribute from BGT.

Table 5: Explanation and frequency of the codes used to compare the attributes

Code	Explanation	Amount	%
A1	BGT and TOP10NL attribute have a similar definition.	2	2%
A2	TOP10NL and BGT attribute have a similar meaning, but provide different information due to different attribute values (schematic heterogeneity; Bishr 1998)	9	10%
A3	BGT and TOP10NL attribute have a different definition (cognitive heterogeneity; Bishr 1998)	7	8%
A4	The information of the TOP10NL attribute is present in BGT, but limited. Much information cannot be derived.	22	25%
A5	TOP10NL attribute is not present in BGT, neither the information of the attribute	49	55%
Total		89	100%

Table 6: Explanation and frequency of the codes used to compare the attribute values

Code	Explanation	Amount	%
V1	Attribute values have a similar definition	24	6%
V2	Attribute values have a similar definition, but the names are different (naming heterogeneity; Bishr 1998)	20	5%
V3	Attribute value exits only in BGT, can be added to TOP10NL	6	1%
V4	Attribute values have a different definition (Cognitive heterogeneity; Bishr 1998)	8	2%
V5	TOP10NL Attribute values are merged into a BGT attribute value (Schematic heterogeneity; Bishr 1998)	23	6%
V6	Attribute value is present but belongs to different attribute, resulting in loss of some information (schematic heterogeneity; Bishr 1998)	3	1%
V7	The information of the TOP10NL attribute values is present in BGT, but limited. The related attribute value has a different meaning	14	3%
V8	TOP10NL attribute value cannot be derived from BGT	318	76%
Total		416	100%

Table 5 shows codes and the frequency of occurred semantic differences at the level of attributes. Five different possibilities were found. Unique codes are assigned for the attribute, because not only the meaning is compared, but also the attribute values of an attribute. The codes are explained in the coming paragraphs. Individual attribute values are discussed in the next sub section. They have unique codes as presented in table 6.

Table 7: Comparison of TOP10NL attributes and attribute values of the object class "Wegdeel" with BGT content

TOP10NL attribuut	TOP10NL attribuut waarde	Semantiek	BGT object klasse	BGT attribuut	BGT attribuut waarde	Opmerking
type weg	<algemeen>	A2	Wegdeel	functie		Indeling bij BGT verschilt van TOP10NL.
	autosnelweg	V1	Wegdeel	functie	"rijbaan autosnelweg"	Potentieel af te leiden
	hoofdweg	V7	Wegddel	functie	deels "rijbaan autoweg"	definitie "rijbaan autoweg" in BGT niet gelijk aan "hoofdweg" in TOP10NL. Zowel BGT "autoweg" als BGT "regionale weg"
	regionale weg	V4	Wegdeel	functie	"rijbaan regionale weg"	Definitieverschil
	lokale weg	V4	Wegdeel	functie	"rijbaan lokale weg"	definitie 'lokale weg' in BRT en BGT niet gelijk. Onderscheid straat en lokale weg verdwijnt in BGT.
	straat	V7	Wegdeel	functie	"rijbaan lokale weg" en "woonerf"	TOP10NL "straat" voor groot deel onderdeel van 'rijbaan lokale weg' in BGT
	startbaan, landingsbaan	V5	Wegdeel	functie	"baan voor vlieg verkeer"	onderscheid tussen "startbaan, landingsbaan" en "rolbaan, platform" niet mogelijk
	rolbaan, platform	V5				
	overig	V3	Wegdeel	functie	"fietspad", "voetpad", "voetpad op trap", "ruiterpad", "voetgangersgebied", "parkeervlakken"	door samenvoegen potentieel af te leiden. Nieuwe BGT waarden kunnen hier toegevoegd worden als aparte waarde
			Wegdeel	functie	"spoorbaan"	gaat naar objectklasse Terrein
					'overweg"	Dient omgecodeerd te worden naar omliggend wegtype
					"OV-baan", "Inrit"	komt niet voor in huidige TOP10NL
verhardings type	<algemeen>	A1	Wegdeel	fysiek Voorkomen		Potentieel af te leiden
	verhard	V3	Wegdeel	fysiek Voorkomen	gesloten +open verharding	Potentieel af te leiden
	half verhard	V1	Wegdeel	fysiek Voorkomen	half verhard	Potentieel af te leiden
	onverhard	V1	Wegdeel	fysiek Voorkomen	onverhard	Potentieel af te leiden
brugnaam	n.v.t.	A4				Mogelijk af te leiden uit OpenbareRuimteLabels, maar niet bij elke brug
afritnummer	n.v.t.	A5				niet af te leiden
hoogteniveau	n.v.t.	A3	IMGeo_object	relatieve Hoogte Ligging		Definitieverschil

The code A1 (table 5) is assigned when a TOP10NL attribute has a similar meaning as the related BGT attribute and equivalent attribute values are found in BGT. BGT attribute values may also be more detailed. An example is the attribute "verhardingstype". Table 7 shows that this attribute is also present in BGT. The only difference between this TOP10NL attribute and the equivalent BGT attribute "fysiek voorkomen" is the name (Table 7; table A4). In this case a naming heterogeneity occurs (Bishr, 1998).

The code A2 is assigned to a TOP10NL attribute when a related BGT attribute is found with a similar definition, but the information they describe is different. This is caused due to differences at the attribute value level. The TOP10NL attribute "type weg" is similar to the BGT attribute "functie", but the roads are classified differently in both models resulting in different attribute values (Table 7; table A4). This will cause information changes in TOP10NL, when the BGT attribute becomes the only source. This example is a schematic difference (Bishr, 1998).

The code A3 is assigned when equivalent attributes are found, but their definition is different As a result, the attribute describes the same information in a different way. An example is the relative height as already explained in section 5.1. This is comparable with the description of semantic heterogeneity from Bishr (1998).

The code A4 is assigned in cases where a TOP10NL attribute can be found in BGT, but many of its information is not found in BGT. An example is the TOP10NL attribute "brugnaam (NL)" from "wegdeel". This attribute describes the name of a bridge. Probably only a part of the bridge names can be derived from BGT. BGT uses labels that describe public space and are added only for visualization. If a bridge is part of public space its name may be describe using a label. The BGT catalog is not clear if these names are indeed added to the BGT "openbare ruimte labels". Therefore this attribute is assigned the code A4 (Table 7).

The code A5 is assigned when a TOP10NL attribute is not found in BGT and neither the information that is described by the attribute. An example is the attribute "afritnummer". This information disappears in TOP10NL.

Table 8: Explanation and frequency of the assigned colors to the attributes

Colour	Explanation	Amount
(yellow)	Attribute can potentially be derived	40
(red)	Attribute cannot be derived	49
Total		89

Table 8 shows that only 40 attributes can potentially be derived according to the applied comparison of the information models. The amount of attributes that cannot be derived is equal to the amount of attributes with code A5. This is done because of the assumption that an attribute of TOP10NL can potentially be derived from BGT, even with a semantic difference. This will result in changed information in TOP10NL. The users determine if these differences are acceptable.

Table 9 presents per TOP10NL attribute if it can potentially be derived from BGT. The attributes are divided per object class. Table 8 and 9 show that almost half of the TOP10NL attributes can potentially be derived from BGT. This is caused by the fact that TOP10NL contains more attributes than BGT. TOP10NL Attributes that cannot be derived describe concepts of reality that are neglected in BGT. The height attributes are an example of a concept that exists in TOP10NL, but is neglected in BGT.

Not all attributes are equally important. In section 4.2, it is explained that the most important attributes are obligatory. Less important attributes are optional. The attributes that are obligatory are bold and italic in Table 9, assuming these are the most important attributes (Kadaster, 2013a). The results for these attributes are summarized in Table 10. Only half of the obligatory attributes can potentially be derived.

Table 9: Result of the comparison: Assigned colors for the TOP10NL attributes. Important attributes are bold and italic

Wegdeel	Color	Spoor	Color	Waterdeel	Color
Type Infrastructuur	Red	***Type Infrastructuur***	Red	Type Infrastructuur	Red
Type weg	Yellow	***Type spoorbaan***	Yellow	***Type water***	Yellow
Hoofdverkeersgebruik	Yellow	Fysiek voorkomen	Yellow	Fysiek voorkomen	Yellow
Fysiek voorkomen	Yellow	***Spoorbreedte***	Red	Breedteklasse	Red
Verhardingsbreedteklasse	Red	Vervoersfunctie	Red	Breedte	Red
Verhardingsbreedte	Red	Elektrificatie	Red	***Functie***	Red
Verhardingstype	Yellow	***Status***	Yellow	***Hoofdafwatering***	Red
Enummer	Red	Baanvaknaam	Red	Stroomrichting	Red
Anummer	Red	Hoogteniveau	Yellow	Scheeplaadsvermogen	Red
Snummer	Red	***Aantal sporen***	Red	***Status***	Yellow
Nnummer	Red	Brugnaam	Yellow	Brugnaam	Yellow
Status	Yellow	Tunnelnaam	Yellow	Sluisnaam	Yellow
Afritnaam	Red			***Hoogteniveau***	Yellow
Afritnummer	Red			***Voorkomen***	Red
Brugnaam	Yellow			NaamNL	Yellow
Tunnelnaam	Yellow			NaamFr	Yellow
Knooppuntnaam	Red				
Gescheiden rijbaan	Red				
Aantal rijstroken	Red				
Hoogteniveau	Yellow				
StraatnaamNL	Yellow				
StraatnaamFr	Yellow				
Terrein	**Color**	**Inrichtingselement**	**Color**	**Gebouw**	**Color**
Type landgebruik	Yellow	***Type Inrichtingselement***	Red	Type gebouw	Red
Fysiek voorkomen	Yellow	NaamNL	Yellow	***Hoogteklasse***	Red
Voorkomen	Yellow	NaamFr	Yellow	hoogte	Red
Hoogteniveau	Yellow	***Status***	Yellow	Hoogteniveau	Yellow
NaamNL	Yellow	Hoogte	Red	NaamNL	Red
NaamFr	Yellow	Nummer	Red	NaamFr	Red
		Hoogteniveau	Yellow	***Status***	Yellow
Relief	**Color**	**Functioneel gebied**	**Color**		
Type relief	Yellow	***Type functioneel gebied***	Red		
Hoogte	Red	NaamNL	Red		
Functie relief	Yellow	NaamFr	Red		
NaamNL	Red				
NaamFr	Red				
Status	Yellow				
Hoogteklasse	Red				
Hoogteniveau	Yellow				
Registratief gebied	**Color**	**Geografisch gebied**	**Color**		
Type registratief gebied	Red	***Type geografisch gebied***	Red		
Nummer	Red	NaamNL	Red		
NaamNL	Red	NaamFr	Red		
NaamFr	Red	Aantal Inwoners	Red		

Table 10: Explanation and frequency of the assigned colors to the important attributes

Colour	Explanation	Amount
Yellow	Attribute can potentially be derived	16
Red	Attribute cannot be derived	13
Total		29

5.2.3 The semantic differences found on the attribute value level

Unique codes are also assigned at the attribute value level. A TOP10NL attribute value is assigned the code V1 if a similar attribute value with the same definition and name exist in BGT. An example is the value "autosnelweg" from "type weg" (Table 7). When only the name of the attribute value differs, but the definition is similar, the value V2 is assigned. An example is the value "op brug" from "terrein, fysiek voorkomen" that is called "overbruggingsdeel" in

BGT (Table 11). This is defined by Bishr (1998) as naming heterogeneity. The value V3 is assigned when a TOP10NL attribute can be extended with additional BGT attribute values. An example of a BGT attribute value that can be added to the TOP10NL attribute "type weg" is "fietspad" (Table 7).

The code V4 is assigned when equivalent attribute values have a different definition. An example is "wegdeel, regionale weg" (Table 7). The code V5 is assigned when multiple TOP10NL attribute values are merged in one BGT attribute value resulting in a loss of detail. For example, the TOP10NL attribute values "type weg, startbaan; landingsbaan" and "rolbaan; platform" that are merged into BGT "baan voor vliegverkeer" (Table 7). The code V6 is assigned when TOP10NL attribute values are present in BGT, but belonging to another attribute. Due to this difference information is lost when the value is derived from BGT. An example is the value "moeras" that belongs to "terrein type" in BGT (Table 11). In TOP10NL the value "moeras" belongs to the TOP10NL attribute "voorkomen". The attribute "voorkomen" is an additional attribute beside the attribute "type landgebruik" and describes how swampy a terrain object is. A TOP10NL object can be classified as grassland for the attribute "type landgebruik" and for the attribute "voorkomen" the value "moeras" can be assigned. This is not possible in BGT, because the values "moeras" and "grassland" belong both to the attribute "type landgebruik". Therefore this object is assigned one value in BGT. Some information is lost compared with the current TOP10NL.

Table 11: Comparison of TOP10NL attributes and attribute values of the object class "Terrein" with BGT content

TOP10NL attribuut	**TOP10NL attribuut waarde**	**Semantiek**	**BGT object klasse**	**BGT attribuut**	**BGT attribuut waarde**	**Opmerking**
fysiek voorkomen	<algemeen>	A2				Attribuut bestaat in BGT uit verschillene objectklassen
	overkluisd	V8				
	in tunnel	V1	Tunneldeel			
	op brug	V2	Overbruggingsdeel			
voorkomen	<algemeen>	A2				Waarden aanwezig in BGT, maar niet in een apart attribuut. Hierdoor zal informatie verdwijnen.
	met riet	V6	Begroeid Terreindeel	fysiek Voorkomen	rietland	
	dras, moerassig	V6	Begroeid Terreindeel	fysiek Voorkomen	moeras	

Table 12: Comparison of TOP10NL attributes and attribute values of the object class "Waterdeel" with BGT content

TOP10NL attribuut	**TOP10NL attribuut waarde**	**Semantiek**	**BGT object klasse**	**BGT attribuut**	**BGT attribuut waarde**	**Opmerking**
functie	<algemeen>	A5				Vrijwel niet af te leiden
	Drinkwaterbekken	V8				Niet af te leiden
	haven	V8				Niet af te leiden
	natuurbad	V8				Niet af te leiden
	viskwekerij	V8				Niet af te leiden
	vistrap	V8				Niet af te leiden
	vloeiveld	V8				Niet af te leiden
	waterval	V8				Niet af te leiden
	waterzuivering	V7	OverigBouwwerk	type	bezinkbak	BGT bezinkbak is onderdeel van BRT waterzuivering
	zwembad	V7	OverigBouwwerk	type	bassin	BGT 'bassin' wordt ook voor andere waterbakken gebruikt zoals dok. Informatie is aanwezig maar moeilijk af te leiden tot TOP10NL attribuut.
	overig	V8				Niet af te leiden

The code V7 is assigned when the information of a TOP10NL attribute value is partly present in BGT. Often not all objects are found in BGT and the related attribute values often have a different definition. It is questionable how many TOP10NL objects can be derived from BGT with this difference. An example is the value "functie water, zwembad", with is part of BGT "Overig bouwwerk, bassin"(Table 12). Finally, code V8 is assigned when the value is not present in BGT. An example is the value "functie water, haven" (Table 12). The complete assignment of codes is found in appendix 3.

416 TOP10NL attribute values are compared and a big majority cannot be derived from BGT (Table 6). A lot of these attribute values are found in object classes and attributes that are not or only limited present in BGT. TOP10NL distinguishes many different building types, lay out element types and functional area types. BGT distinguishes only a few. When looking past the 76% of the attribute values that are not present in BGT the most occurred difference between BGT and TOP10NL is that TOP10NL values are merged into more general BGT values (code V5). This seems surprising because one would expect that BGT describes more detail than TOP10NL, because BGT describes a larger scale. However, due to the different purposes TOP10NL describes some features more detailed than BGT. TOP10NL contains more semantic information than BGT, while BGT has a more detailed geometry.

The codes are again summarized into two colors that indicate the possibility to derive the attribute values. Table 13 shows that only 98 attribute values can potentially be derived according to the comparison of the information models.

Table 13: Explanation and frequency of the assigned colors to the attribute values

Colour	Explanation	Amount
(yellow)	Attribute value can potentially be derived	98
(red)	Attribute value cannot be derived	318
Total		416

The comparison of the information models showed that TOP10NL information is often not found in BGT. Furthermore, if the information is available in BGT there are semantic and schematic differences.

5.3 Examples of geometric and representation differences.

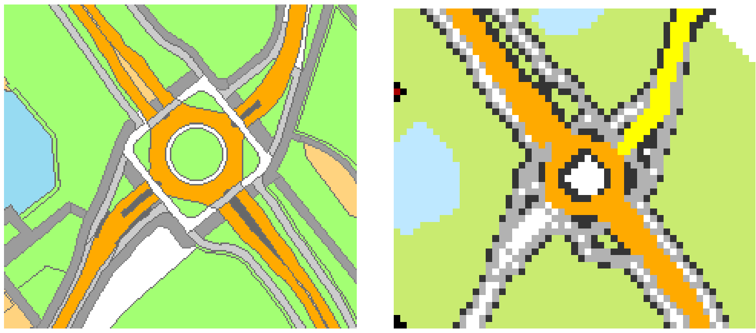
The goal of this section is to show differences in representation of real world objects between BGT and TOP10NL using examples. The examples are chosen so that they match some aspects that are important for users. The legend belonging to the examples is presented in figure 7. This is based on the user feedback presented in chapter 6. Most examples deal with polygon objects, but one example features line objects, to show the different role of the different geometry types. It was not possible to present an example with point objects, because the used BGT sample set did not contain any point objects.

The cause of the different representations is explained by the theory of Aalders (2001) in section 4.1 and the different purposes mentioned in section 5.1. Due to the different purpose the scale of both products is different and also the objects added in the database. Scale is an important factor to explain the geometric differences. Objects are generalized to get a usable map on a small scale. The surveying rules are adjusted to describe the objects required. An example is the surveying rules for walls. A wall is only added in TOP10NL when the length is more than 50 meters and height is more than two meters (Kadaster, 2013a). A wall is included in BGT when the length is more than one meter and is higher than 50 centimeters (Ministry of infrastructure and environment, 2012a). The scale also influences the geometry type of an object. In TOP10NL all walls are modeled as a line object (Kadaster, 2013a), while in BGT walls are a polygon object when the width of a wall is more than 30 centimeter (Ministry of infrastructure and environment, 2012a). As a result there are differences between objects that describe similar phenomena caused by the purpose, scale and the surveying rules. The resulting maps are also different as is presented in the coming figures.

The surveying rules also help to interpret situations in which real world phenomena can be interpreted in different ways. An example is a crossing between a local road and a cycle path (Figure 8). The crossing of the cycle path with the local road can either get the value local road or the value cycle path. A hierarchy regarding road types is available in the surveying rules in TOP10NL. Based on that hierarchy local roads are prioritized above cycle paths. The crossing object is thus represented as local road in the whole TOP10NL. The hierarchy prevents that in some cases the cycle path is represented on a crossing instead of a local road (Kadaster, 2011).

Figure 7: Legend of BGT (A) and TOP10NL (B)

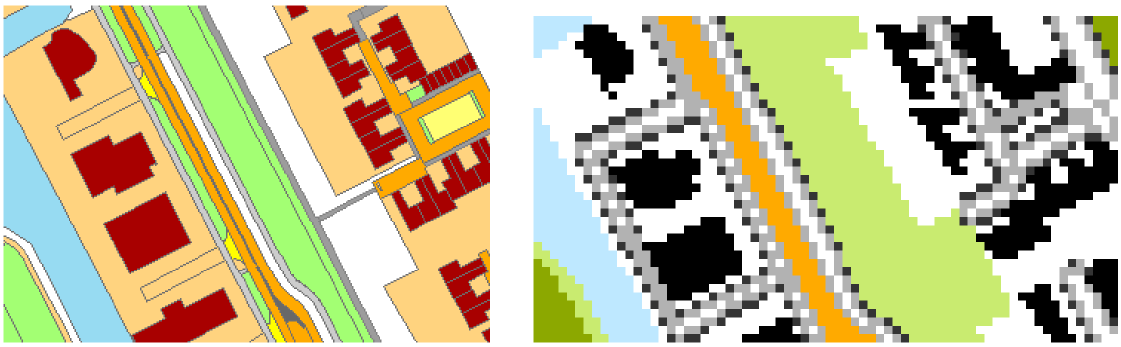
The surveying rules of BGT however lack a certain hierarchy. The surveying rules do not give any guidance in the case of a crossing. The source holders have the freedom to interpret the crossings according to their insights. Some source holders may prioritize the cycle paths above the local road, while other source holders may prioritize the local road. A source holder may even apply both interpretations in their data. As a result data becomes inconsistent due to different interpretations of different source holders that are allowed by the surveying rules. This inconsistency could lead to strange results when the data is used for analysis. This example could lead to strange outcomes when a "thin out road network" tool is used in a GIS. The tool may remove local road and preserve cycle paths in the data of a certain source holder, but in the data of a different source holder the opposing happens.



A B

Figure 8: Example of a roundabout with cycle path in BGT (A) and TOP10NL (B)

Figure 8 shows a roundabout. In the left picture the road is interrupted by the cycle path that is separated from the roundabout. This is the result of the rule that BGT road objects are only assigned one road type attribute. In TOP10NL objects may be assigned more than one road type. TOP10NL also has a hierarchy in road types that determines which road is displayed in case of a crossing. The lack of such a hierarchy in the BGT results in the interrupted road of Figure 8A. In Figure 8B the individual road objects are not visible, because they are too small. Another difference between BGT and TOP10NL is the existence of the dark grey auxiliary road parts in Figure 8a. These objects are generalized in TOP10NL, because they are too small and they do not fit in the purpose of TOP10NL.

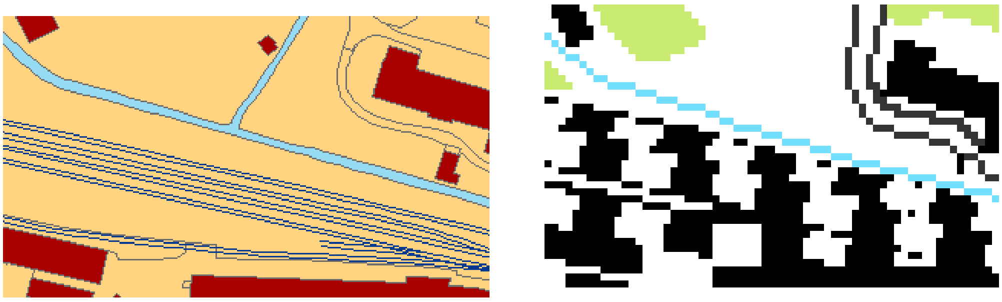


A B

Figure 9: Example of a road with a cycle path in BGT (A) and TOP10NL (B)

Another example is shown in Figure 9. There is a clear difference in the representation of the road in both pictures. The BGT road in Figure 9A contains a lot of detail. The separated driving directions of the road are visible. The map also shows the verges between the road and the cycle path. All these details are generalized in Figure 9B. The cycle paths are however separate objects that fall inside the road outline. The roads are also classified differently. In Figure 9A most road parts are classified as local roads, while in Figure 9B one road is classified as regional road, and the other roads are classified as streets. The shape of the buildings is quite similar. In Figure 9A each house is modeled as unique object, while in TOP10NL each row of houses is an object.

The third example is shown in Figure 10. A few small water objects are visible in Figure 10A. In TOP10NL small water objects are generalized and represented with a line instead of a polygon. The waterway running north-south in Figure 10A is disappeared in Figure 10B. This might be a mistake in TOP10NL. The small building in Figure 10A is not generalized, but is disappeared in Figure 10B. This building did not pass the criteria stated in the TOP10NL surveying rules. The surface is too small. Railways are also visible in this example. The railway symbol in TOP10NL is oversized so that the railways are still visible on the target scale. The BGT example contains more lines that represent railways. In BGT each line represents a single track (Ministry of infrastructure and environment, 2012a). In TOP10NL a generalization took place. The railway network is thinned out and one line can represent multiple tracks. This is the difference in railway representation in BGT and TOP10NL. It is less complex than the differences in road representation as presented in Figure 9.



A *B*

Figure 10: Example of water and railway objects of BGT (A) and TOP10NL (B)

An example with point objects was not available. It is expected however that not much difference in representation would be found when point objects are compared. The only difference that can occur is that the location of the object is more accurate in one of the datasets. In that case the most accurate location can be used.

These examples show that although BGT and TOP10NL describe the same phenomena, they often do it in a different way. This is caused by the difference in purpose and scale and the surveying rules that determine how real world phenomena are translated into objects. When BGT will be used as source for the TOP10NL then the objects of BGT have to be generalized and adjusted to meet the TOP10NL surveying rules. Automated generalization research is necessary to find out how BGT objects can be transformed into TOP10NL objects. This is especially important for polygon objects, because the shape of these objects differs between BGT and TOP10NL. This is caused by fact that BGT polygon objects are more detailed than TOP10NL polygon objects. Furthermore BGT contains small polygon objects like auxiliary road parts. These objects should be removed when converted to TOP10NL. The empty space should be filled by the surrounding objects. More information about generalization possibilities can be found in Foerster et al. (2008) and Hofman et al. (2008). Line objects are probably easier to generalize, because there is less difference in shape. The example shows that some lines are removed.

The examples show some of the differences in geometry between BGT and TOP10NL objects. They show that only researching the semantic differences is insufficient to draw conclusions about the possibility that a TOP10NL value can be derived from BGT, due to the geometric differences. These geometric differences have to be overcome when TOP10NL objects are derived from BGT objects. Research is necessary to determine the major obstacles and to determine if BGT objects are useful to derive TOP10NL objects. The findings in this research can be used as input. The comparison of the information models presents the differences in the definitions and names of object classes, attributes and attribute values and help to determine where information will change or disappear.

6 Users feedback about modified information of TOP10NL

In this chapter the user feedback is presented. The goal of the consultation was to find out which information is crucial for the usage of TOP10NL and how problematic it is for users when TOP10NL information changes. Besides the users, the requirements of the Dutch law regarding TOP10NL and the INSPIRE requirements are presented.

6.1 National and international requirements

In this section requirements for the TOP10NL are discussed. First the national requirements are discussed. These are stated in the Dutch law. International requirements are the INSPIRE requirements. INSPIRE is relevant because TOP10NL is marked as one of the input datasets for several themes.

6.1.1 The Dutch law

TOP10NL is part of the key registration topography (BRT) since 2008. As a result the TOP10NL should meet the requirements that are stated in the Dutch law regarding key registrations. Most of these requirements are generic requirements. For instance the requirement that governmental organizations are obligated to use TOP10NL if they need a map on the scale of TOP10NL. Furthermore all data is surveyed one time and used multiple times (Hofman, 2008b).

Regarding the content of TOP10NL there is one article in the Dutch law that is important. It is article 98a of the Dutch law for the Kadaster (Kadasterwet). This article deals with the BRT. One part of the article mentions explicit the ten object classes that should be in BRT and are in TOP10NL (Ministry of Infrastructure, 2007). It means that all current object classes should be maintained in order to meet the requirements of the law.

6.1.2 INSPIRE requirements

TOP10NL is used to meet INSPIRE requirements. INSPIRE aims to create a European Spatial Data infrastructure (SDI) (INSPIRE, 2013). INSPIRE is filled with data from the European countries and is divided into several themes. These themes are classified in three annexes. This is done to give members sufficient time to convert their data to INSPIRE standards. For each theme national datasets are assigned to fill an INSPIRE theme. The TOP10NL is used for the following themes from annex 1(Geonovum, 2009):

- "road network";
- "railway network";
- "cableway network";
- "hydro-physical water";
- "geographical names".

Table 14 shows which attributes of TOP10NL matches with required INSPIRE attributes. At the moment data specifications are known only for INSPIRE annex 1. For annex 2 and 3 the specifications are not yet decided (Geonovum, 2013). Therefore these annexes are ignored. INSPIRE uses TOP10NL data. Therefore it can be seen as an additional user. For names it was not clear which names available in TOP10NL were required. Therefore INSPIRE is not taken into account for the name attributes.

In total there are 23 attributes that are used to meet INSPIRE requirements. These are presented in Table 14. Most attribute values of these attributes are also required for INSPIRE.

Furthermore there are eight attribute values mentioned in Table 15 that are also required for INSPIRE. These belong to attributes that are not required for INSPIRE.

Table 14: TOP10NL attributes that matches INSPIRE annex 1 attributes

Object class	**Wegdeel**	**Spoor**	**Waterdeel**
Attributes	Type Infrastructuur Type Weg Hoofdverkeersgebruik Verhardingsbreedteklasse Verhardingstype Aantal rijstroken E Nummer A Nummer N Nummer S Nummer Fysiek voorkomen	Type Infrastructuur Type spoor spoorbreedte Aantal sporen Vervoersfunctie Elektrificatie Fysiek voorkomen	Type water Breedte Fysiek voorkomen Breedteklasse Functie Water

Table 15: Individual TOP10NL attribute values required for INSPIRE

Object class	**Gebouw**	**Inrichtingselement**	**Terrein**	**Relief**
Attribute values	Dok	Kabelbaan mast Kabelbaan Station Sluisdeur Steiger	Steiger	Kade, wal

6.2 User input from interviews

The result of the first step is used as input to show users the semantic differences between BGT and TOP10NL. The comparison table of figure A3 was used. The interview was held using this information. When users mention that certain data is crucial to be available, then that is an important argument to keep that information in TOP10NL. When it is not found in BGT the data has to be surveyed or other sources should be used. On the other side, users may not need all information that is available in TOP10NL.

6.2.1 Alterra

Maarten Storm of Alterra is interviewed, because they use TOP10NL for several applications. Alterra is a research institute in close cooperation with Wageningen University. Applications that are developed using TOP10NL are the LGN (Land use map), the TOP10smart and VIRIS. The LGN is a land use map with strong emphasis on the rural areas. TOP10smart is a conversion from TOP10NL into a multi-scale raster map. VIRIS is a spatial information system used to monitor landscape changes in time. Alterra often performs these analyses. To compare the changes in the landscape, changes in the data model should be avoided. Therefore Alterra prefers an unchanged TOP10NL. However when changes are inevitable Alterra will adjust its analyses (Storm, 2013).

Another important factor for Alterra is the homogeneity of the data. The current TOP10NL is a consistent database for the whole Netherlands. The BGT has to prove this yet. BGT contains many different source holders (Ministry of Infrastructure, 2012a). As a result the risk is much higher that different interpretations will occur between different source holders. This is worrying Alterra (Storm, 2013).

The Alterra products focus on the rural areas. Therefore the most interesting object class for Alterra is "Terrein". Although the information of this object class is used for TOP10smart and the LGN, the fact that some terrain is less detailed in BGT than TOP10NL is not a big problem for Alterra. For TOP10smart the consequence is less detail. For LGN there are no big consequences as TOP10NL is just one of the sources.

Several elements of the object class "Inrichtingselement" were mentioned as important and interesting. The following objects were mentioned:

- Tree (boom);
- Tree-line (bomenrij);
- Hedge (heg, haag);
- Fence (hek).

From other object classes the following values are important for Alterra:

- Glass house (kas, warenhuis);
- Fish farm (viskwekerij);
- Wildlife crossing (ecoduct);
- Artificial dwelling hill (Terp).

An interesting attribute value for Alterra from BGT:

- Dune (duin).

The object classes "functioneel gebied" and "geografisch gebied" are not important. Most objects in these classes are currently represented as point in TOP10NL and are therefore not useful for Alterra. The height information provided in TOP10NL is used only when it is forbidden to use the Dutch height map and is therefore not important (Storm, 2013).

The biggest risk for Alterra of a changed TOP10NL is that the input data for their spatial-temporal analysis changes, leading to a different output and difficulties to compare results of different years. Another important point is that data should be consistent for the whole country.

6.2.2 IPO

The second interview was done with Marjan Bevelander of the IPO. The IPO represents the twelve provinces of the Netherlands. The provinces are obligated to use the TOP10NL for all purposes were the scale of TOP10NL is relevant (Hofman, 2008b). The TOP10NL is used by the provinces when they create maps, visions and plans. Only for maintenance purposes the TOP10NL is not used. The provinces use BGT instead (Bevelander, 2013).

The provinces are responsible for the information model nature (IMNa). IMNa provides a national standard to develop nature maintenance plans. TOP10NL is a source for IMNa. The most important part of TOP10NL for IMNa is the geometry. The attributes of TOP10NL are less important, because IMNa has a very detailed list of attributes that are used to distinguish the different nature and landscape types. (for a complete list see Stoter, 2013). The IPO suggests adding the nature types from IMNa to the terrain classifications in both BGT and TOP10NL, because IMNa is a national standard.

Although the geometry of TOP10NL is the most important part of TOP10NL, there are some values that could be interesting for IMNa. These values are:

- "tree" (boom);
- "tree-line" (bomenrij);
- "hedge" (heg, haag).

Another wish of the provinces is the usage of the cadastral boundaries of provinces and municipalities in TOP10NL. At the moment there is a difference between the boundaries available in TOP10NL and the boundaries available in the cadastral key register. This is confusing for the provinces (Bevelander, 2013).

Although the provinces are obligated to use TOP10NL, there is no specific information in TOP10NL that should be maintained. For IMNa only the geometry is important. Changed attributes and attribute values are not an obstacle. The provinces have a few suggestions that could be taken into consideration.

6.2.3 Autogen Kadaster

The final interview was held with Ron Nijhuis, a representative of the Kadaster Autogen team. This team is responsible for the production of TOP50NL using automatic generalization. The goal of the interview was to find the attributes in the current TOP10NL that are important for that process.

The object classes "Waterdeel" and "Wegdeel" are important for the generalization process. Changes in the classification of road and water parts are not a big problem, although the generalization method has to be adjusted to the new situation. The fact that the road classification is determined by multiple attributes is mentioned as complex. In this case the BGT approach is preferred. BGT classifies roads using one attribute. TOP10NL uses multiple attributes. The removal of the TOP10NL attribute "hoofdverkeersgebruik" is an interesting possibility.

The BGT misses a few attributes that are at the moment in TOP10NL and are important for TOP50NL. Examples are the "hart lines" (hartlijnen), the road and water width and the road and water width classes. However, recent research of the Kadaster about the possibilities produce the TOP10NL from the BGT using automated generalization showed that it may be possible to derive that information from the BGT (Altena et al., 2013; Nijhuis, 2013).

Another difference is the interpretation of relative height (see section 5.1) A test has been performed by the Kadaster to convert the BGT relative height to TOP10NL relative height. The presented results showed good possibilities to convert the BGT relative height to the TOP10NL relative height (Altena et al., 2013). Street names can be found in the label points of BGT. Otherwise the BAG may be used as source. For bridges and tunnels an overlay is necessary.

Geometric differences are also more important than thematic differences in the object classes "terrein" and "gebouw". This is caused by an important difference between BGT and TOP10NL. In BGT buildings are part of the ground level. In TOP10NL buildings overlay the terrain class. As a result when BGT is generalized into TOP10NL gaps will appear on the place of the buildings. These gaps have to be filled with the surrounding terrain (Nijhuis, 2013).

In TOP10NL height is modeled in the object classes relief. Although BGT does not contain any height related object class there are some values that may be used as input. These values are:

- Slope (op talud);
- Top line (kruinlijn);
- Noise barrier (geluidsscherm).

From "Inrichtingselement" the following two attribute values are important:

- Tree;
- Tree line.

In the other object classes there are not many important things. In TOP10NL the object class railway contains the attribute "aantal sporen". This attribute can be derived from BGT during the generalization process. Furthermore BGT describes the values "weir" (kering). This could be a nice addition to TOP10NL, for instance to represent the dikes (Nijhuis, 2013).

The geometric differences between BGT and TOP10NL are more important than the thematic differences for the autogen Kadaster team. BGT misses a few attributes that are necessary to build TOP50NL using automated generalization. Some of them can be derived applying GIS techniques. An important requirement for this user is that the BGT data is consistent. Otherwise the generalization model will not work or produce invalid results.

At the moment TOP50NL is harmonized with TOP10NL. It is expected that when TOP10NL changes TOP50NL changes also. Like Alterra, Autogen Kadaster prefers minimum changes.

6.2.4 CBS

Instead of an interview with a representative of the CBS, a recent study of Stoter (2013) is used to find the user needs. At this moment the CBS develops two products based on TOP10NL. These are the Gemeentefonds (municipality funding) and the BBG (bestand bodemgebruik; land use map Netherlands).

For the Gemeentefonds, it is important to know the surface of land, water and buildings. Currently the used criteria are based upon TOP10NL. Furthermore at least three different types of buildings should be distinguished:

- "glass house" (kas, warenhuis);
- "storage tank" (opslagtank);
- other buildings.

BGT distinguishes "opslagtank", but not "kas, warenhuis". For this application it is crucial that the mentioned buildings are distinguished.

Regarding the surface of water, the TOP10NL attribute "breedteklasse water" is used. Only water with a width wider than 6 meter is seen as water if the surface and length meet the conditions. Water width is not an attribute in BGT, but should be present in TOP10NL (Stoter, 2013).

For the BBG, Stoter made a mapping to see if BGT objects could be converted to BBG objects. For most objects a conversion is possible, but there are some BBG values that cannot be derived from BGT, but are currently derived from TOP10NL. These are (Stoter, 2013):

- "Glass house" (kas, warenhuis);
- "Built up area" (bebouwd gebied);
- "Funeral" (Begraafplaats).

6.3. Kadaster sources

The final sources of user needs are a survey and a workshop. Both were organized by the Kadaster with the goal to evaluate and improve TOP10NL. The workshop was organized in 2010. The survey was held in 2011. The first part of this section deals with the survey. In the second part the results of the workshop are presented.

6.3.1 Kadaster survey

The reason for the Kadaster to organize a TOP10NL survey in 2011 was to evaluate the quality and the content of the product. The results would be used to improve the product. 75% of the surveyed people works for a governmental organization. 78% from the response worked at a governmental organization. 69 people did fill in the survey. The main usages of TOP10NL of these people are orientation and visualization. TOP10NL is not often used to do GIS analysis or to link the data with other datasets.

The object classes "waterdeel", "wegdeel", "terrein" and "gebouw" are most often used. These are the most important object classes. Opposite the object classes "hoogte" and "relief" are least used (Figure 11). The object class "hoogte" is nowadays merged with the "relief" object class (Kadaster, 2013a). The most frequently used object classes are also the classes of which the quality of the data can be improved most. Both the completeness and the actuality could be better according to the respondents. Functional areas were mentioned as incomplete. Respondents also missed the attribute building type (Den Ouden, 2011).

Another part of the survey is the part where users could mention suggestions for a future TOP10NL. Some suggestions were:

- Combine AHN (Dutch height map) data to TOP10NL;
- Add street names to hart lines;
- Link with BGT;
- Integration with agriculture;
- Integration with water and add more different water types;
- Buildings from BAG;
- More nature;
- Add toponyms of TOP25 raster;
- Add slope as polygon;
- Link with national road database.

The suggestion to link BGT and TOP10NL was mentioned often.

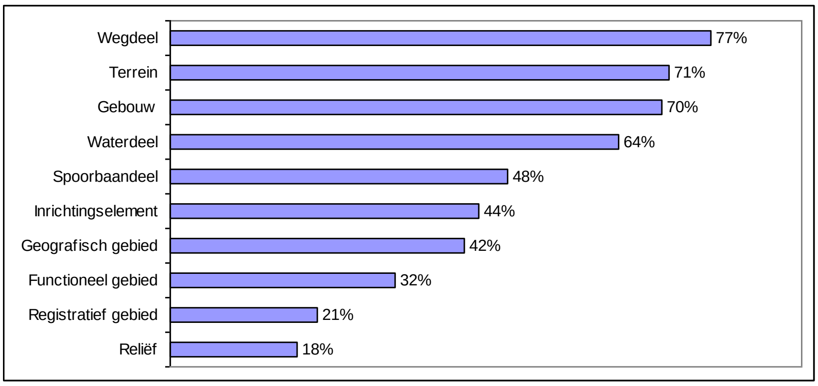


Figure 11: Percentage of users that consult a TOP10NL object class
Source: Den Ouden, 2011

Respondents had also the possibility to suggest missing data. The following suggestions were made (Den Ouden, 2011):

- Add more names (especially street names);
- Add nature types;
- Distinction of functional areas;
- Trees and hedges.

6.3.2 Internal workshop

The final source of user input in this research is an internal workshop held by the Kadaster in 2010 (Kadaster, 2010). The goal of this workshop was to evaluate TOP10NL. The results of the evaluation were used to improve TOP10NL. The participants of the workshop were all working at the Kadaster although at different divisions. Participants were asked to think about possible improvements for the TOP10NL. The main topics of improvement were:

- surveying rules;
- the complexity of the data model;
- associations with other key registers;
- topicality of the data.

The participants noted that the data model of TOP10NL is complex and partly based on the precursor of TOP10NL. Many surveying rules are still based on old purposes and are not relevant for new customers. The data model contains many cartographic restrictions. Examples are the pumping stations. They are only added to TOP10NL if they are adjacent to a water body that is part of the Dutch main drainage system.

Another mentioned point of the current data model is that it contains attributes that are empty. These attributes were added during the development of TOP10NL. The aim was to fill these attributes, but at the moment there are still attributes that are not filled (Te Winkel, 2013; see also section 4.2). These empty attributes are misleading for the users. It seems like information is available in the database, while it is not. The street names and building names are examples of partly filled attributes.

Suggestions are made to add new objects in the TOP10NL database. Dikes and roundabouts are suggested to add as separate objects. Participants also mentioned that some data could be added from other sources. Instead of maintaining the incomplete street names the BAG could be used as source. AHN is a possible source for the height information. The key register of the Kadaster (BRK) is a possible source for the administrative boundaries (Kadaster, 2010). Many of the suggestions made by participants are not applied yet although three years have passed since the workshop. The topicality of the TOP10NL is improved and meets the requirements of the law to have a topicality of 2 years (Kadaster, 2013a).

6.4 Results of the consultation: Important TOP10NL information

The results of the user consultation are summarized here. Some of the suggested alternative sources are further presented in the second part of this section.

Figure 11 shows the importance of the TOP10NL object classes. Three groups are distinguished based on this figure. Group 1 consists of “wegdeel”, “waterdeel”, “terrein” and “gebouw”. These are the most consulted object classes. They are also necessary because without these classes a topographic map cannot be made. The consulted users need the geometry and some attributes of these classes for their own products.

Group 2 consists of “spoor”, “inrichtingselement” and “registratief gebied”. These object classes are still frequently consulted. Some values of “inrichtingselement” are important for users. Trees are mentioned multiple times in the previous sections. Administrative areas are important for the IPO. Group 3 consists of the remaining object classes. These classes are least consulted by users and are not important for users. Alterra even has stated that functional areas are at the moment unimportant.

Table 16: Result of the comparison per group of object classes

Color	Explanation	Amount of Group 1	Amount of Group 2	Amount of Group 3
(yellow)	Attribute can potentially be derived	26	10	4
(red)	Attribute cannot be derived	25	13	11
Total		51	23	15

Table 16 presents the results of the comparison per group. Most TOP10NL attributes are found in the first group. The object classes "wegdeel" and "waterdeel" contain a lot of attributes, but half of them are not found in BGT. In group 2 a majority cannot be found in BGT. Most attributes of the final group cannot be found in BGT. Table 9 presents the outcome per attribute.

The users that were interviewed preferred a TOP10NL without changes. If TOP10NL changes these users will adjust to the new situation. IPO and autogen Kadaster stated that the geometry of objects is more important for their applications than the semantic content in TOP10NL. The consistency of the data is an important quality aspect regarding TOP10NL and users are worried that the usage of BGT for TOP10NL lead to inconsistency in the data due to the fact that BGT has multiple source holders and surveying rules that can be interpreted in different manners (see section 5.3). Users expect that phenomena in the real world are represented in an unambiguous manner. Inconsistency may result in applications that do not work correctly or produce strange results. The VIRIS application of Alterra and the automated generalization process of Autogen Kadaster are examples of application that require consistent data (Storm, 2013; Nijhuis, 2013).

Table 17: most important TOP10NL attributes according to users

Wegdeel	Waterdeel	Terrein	Gebouw
type weg Hoofdverkeersgebruik verhardingsbreedteklasse relatieve hoogte	relatieve hoogte type water breedteklasse	type terrein relatieve hoogte	type gebouw

Table 18: Important attribute values for users

Waterdeel	Terrein	Gebouw	Inrichtingselement	Relief	Geografisch gebied
viskwekerij	ecoduct bebouwd gebied begraafplaats	kas, warenhuis opslagtank	boom bomenrij heg, haag hek	talud geluidsscherm	terp

Most of the consulted users did not specify attributes during the consultation. However based on the consultation ten attributes are selected as important. These are found in the most important object classes of group 1. Table 17 presents the ten attributes marked as important based on the user consultation. The "type attributes" are added because they are necessary to distinguish different objects. Width classes are important for CBS and Kadaster autogen. Autogen also mentioned "relatieve hoogte" and "hoofdverkeersgebruik".

Users also mentioned several attributes values. These values are stated in Table 18. The mentioned attributes and attribute values should be maintained in the TOP10NL information model. Information that cannot be derived from BGT should be surveyed or derived from another source. Some users did also miss information in TOP10NL. Dikes and roundabouts where mentioned multiple times. The provinces want to add nature types to TOP10NL.

6.4.1 Suggested datasets

Another interesting result is that several users mentioned other sources that could be used for TOP10NL. The BAG, AHN and BRK were mentioned by several users and are presented in this sub section.

The key register of buildings and addresses (BAG) is a key registration that registers all buildings and addresses in the Netherlands, with the municipalities as source holder (Kadaster, 2013b). The BAG consists of the geometry and identity of the buildings. The building identity is already used in BGT (Ministry of Infrastructure and environment, 2012a, p19). Furthermore, the BAG offers also several names to map the addresses and public spaces. These names are used in BGT to fill the attribute “Openbare Ruimte”. Street names are an example. The BAG is a potential source to add names in the TOP10NL database.

The key registration Kadaster (BRK) can be used to add administrative areas at the national, provincial and the municipal level in TOP10NL. The BRK is a dataset for the cadastral registration of parcels and property (Kadaster, 2013c). At the moment the TOP10NL administrative boundaries differ from the BRK boundaries. This situation causes problems for the IPO, one of the consulted TOP10NL users (see 6.2.2).

The AHN2 is a detailed height dataset of the Netherlands developed by Rijkswaterstaat and the water boards. It is available as a raster and a point file (Waterschapshuis, 2013).This could be a good source for the relief information.

However when adding information from other products into TOP10NL, the problem remains that data is surveyed with a different purpose than TOP10NL. A conversion of the data is probably necessary to fit with the TOP10NL purpose. Research is necessary to investigate the possibilities to transfer and convert data from the mentioned datasets into TOP10NL data.

7 Discussion

In this chapter the research is discussed. The discussion is divided into three parts. The first parts discusses the applied method. The second part discusses the results. In the third part the results are compared with other relevant work.

7.1 Discussion about method

Figure 2 presented three main steps that should be researched to be able to derive TOP10NL from BGT. This research focused on the first main step. The information models were compared and users were asked to give feedback about the found differences between BGT and TOP10NL and the important information in TOP10NL.

The information models were compared to find the semantic differences between TOP10NL and BGT. Some examples were used to present some of the geometric differences. The examples show that objects that have similar attributes in the information model are represented differently on the map. These examples show that the results of the comparison of the information models are insufficient to state conclusions about possibilities to generalize TOP10NL data from BGT data. Only the potential derivation could be stated. The applied method is not sufficient to make predictions about the result of automated generalization.

The second part of the research aimed to find important TOP10NL information for users and the consequences they would face when TOP10NL information changes or disappears. Users did however not mention many attributes and attribute values during the consultation. The users did not always have an opinion, or did not really know if an attribute is important for their usage. The comparison table did not really help them to find the important information. It was difficult for users to estimate the consequences for their applications when information changes even though the changes were presented in the table. The use of the comparison table during the consultation was limited. A few map examples could have been useful to show users some geometric differences and help users to estimate the consequences of a changed TOP10NL for their applications.

A weak point of this research is the limited user consultation. Only three users were interviewed. Information from a fourth user was found in a study. Furthermore a survey and workshop were used. Both are held a few years ago while TOP10NL has been changed recently. Furthermore the usage of TOP10NL has increased, especially in companies (Bregt et al., 2013). These new users may have different wishes and the results would probably be different.

7.2 Discussion about results

The comparison showed that differences are caused due to a different purpose of both products. Both products are developed independently from each other and this has resulted in many schematic and semantic differences. The schematic differences are a result of different classifications of attribute values. As a result the meaning of equivalent attribute values is often different. The difference in representation also causes differences. The scale of BGT allows for a more detailed representation, while in TOP10NL many details are generalized into larger objects. These differences mainly occur with polygon objects. The surveying rules cause also differences in representation. TOP10NL has strict surveying rules that try to prevent multiple interpretations, BGT surveying rules allow different representations resulting in potential data inconsistencies.

The comparison presented also that many TOP10NL information would be lost when BGT becomes the only source. The object classes relief, functional area, geographical area and administrative area will almost disappear. A few attribute values of BGT may be an interesting addition to TOP10NL. All these differences give an indication that TOP10NL probably will change when BGT becomes the source. It is not possible to state conclusions that certain content can be derived without comparing the geometric differences and automated derivation tests.

The law investigation revealed that changes in the attributes and attribute values of TOP10NL are allowed. The consulted users preferred a TOP10NL with minimum changes. The consistency and geometry of the data are important because these aspects are used in their own applications. Semantic information is less important because TOP10NL is often one of the input sources for the application of users. If TOP10NL is changed due to BGT derivation users will adjust their applications. Both Alterra and autogen Kadaster have mentioned that they have to change their models when TOP10NL is changed.

All interviewed users did mention some important attributes and attribute values. They did not mention many values, but each user mentioned different values. Only the trees were mentioned by all consulted users. INSPIRE requires different information than the information that is requested by the consulted users. The values that users need depend on their applications and that explains these differences. The user consultation shows that TOP10NL is used for different reasons.

Users also suggested using more sources for TOP10NL. Mainly the AHN, BRK and BAG were mentioned. It is beneficial for users that features are described similar in TOP10NL and the source dataset. Different descriptions cause problems for users. An example is the case mentioned by IPO. IPO has to deal with different descriptions of the boundaries of administrative areas in TOP10NL and BRK. When TOP10NL reuses the boundaries of administrative areas of BRK this problem is solved. However the suggested datasets are developed with different purposes than TOP10NL which may cause additional changes in TOP10NL.

7.3 Comparing results with other relevant work.

The comparison of TOP10NL and BGT showed that both products describe the real world in a different way. These findings confirm the statements of Uitermark (2001, p7) and Aalders (2001) in literature that each topographic product is representing a selection of real world objects. BGT and TOP10NL are not an exception.

Other literature was used to get insight in different kinds of semantic differences that occur when comparing different information models. Table 2 presented some different classifications proposed by different authors. The classifications have in common that they are generic. Most classification did not only cover the semantic differences, but also differences in representation. The found differences were more specific than the classifications in table 2. Despite the difference in specification the classification of Bishr (1998) was applied, because some of the categories that were distinguished matched the distinguished differences in this research.

The comparison shows which TOP10NL information can potentially be derived from BGT. This has to be proven by automated generalization research. Van Altena et al (2013) performed some automated generalization tests. The results show that semantic differences can be overcome using GIS. Tests to convert BGT relative height into TOP10NL relative height showed promising results (Van Altena et al, 2013). This is an example that shows the possibilities to derive TOP10NL content from BGT despite the differences.

Another interesting result of these tests show that some TOP10NL attributes may be derived from BGT despite the fact that they are absent in the BGT information model. The comparison shows no potential to derive these attributes from BGT. However the test shows it is possible to derive some information using GIS techniques. The "verhardingsbreedteklasse" (road width) is an example. This attribute is not included in the BGT information model, but due to the detail that BGT describes roads the road width can be calculated in GIS and added as separate attribute. Other attribute are presented in Table 19 (Van Altena et al., 2013). Of these attributes, "verhardingsbreedteklasse" and "breedte water" are important according to the user survey in this research. This example shows that automated generalization tests may lead to different results than the comparison and are required to confirm derivation possibilities.

Table 19: TOP10NL attributes that are derived from BGT using GIS operations (Van Altena et al., 2013)

Wegdeel	**Spoor**	**Waterdeel**
Type Infrastructuur Verhardingsbreedte Verhardingsbreedteklasse Hartlijn	Type Infrastructuur Aantal sporen	Breedte Breedteklasse

The findings of the comparison are similar to the findings of Hofman (2008b). In that research TOP10NL was compared with IMGeo, including the part that is optional. The research compared TOP10NL and IMGeo and discussed geometric and semantic issues. The research concludes that TOP10NL and IMGeo are quite different due to their different background and purpose (Hofman, 2008b). These results are similar to the results presented in this research.

8 Conclusions and recommendations

The research is concluded in this chapter. The second part of this chapter presents recommendations for further research.

8.1 Conclusions per sub question

The research question and sub questions were presented in section 1.3. In the coming sub sections sub conclusions are given per question.

8.1.1 Conclusions of sub question 1: the comparison between BGT and TOP10NL

In section 1.3 sub question 1 was stated:
1 What are the semantic differences between TOP10NL and BGT?

TOP10NL and BGT have a different purpose scale. This has resulted in two products that are quite different. The comparison of the information models of BGT and TOP10NL revealed differences. These differences are both semantic and schematic. The meaning of an attribute or attribute value often differs due to schematic differences. The classification of attribute values of a certain TOP10NL attribute does not match with the BGT classification of that equivalent attribute. Table 7 and Table 11 present two examples. Furthermore, definitions of equivalent attributes and attribute values are different. The relative height attribute (see section 5.1) is an example.

Other differences are caused by the scale differences. The result of the scale difference is the removal of details in TOP10NL that are available in BGT. BGT describes many objects like auxiliary roads parts. These objects do not exist in TOP10NL because they are too small and they are generalized into bigger objects. These differences are also visible on the map of both products (section 5.3).

This result in the conclusion:

Semantic and schematic differences exist between BGT and TOP10NL information due to differences in purpose and scale.

8.1.2: Conclusions of sub question 2: The user consultation

Sub question 2 was stated in section 1.3:
2 What is the user perception regarding modified information in TOP10NL?

In the second part of the research several users and relevant sources were consulted. An investigation of the Dutch law showed that only the object classes of TOP10NL are obligatory. Based on the findings in law a conclusion is stated:

The Dutch law allows changing the TOP10NL content except for the object classes that are obligated for the law.

The consulted users stated that the geometry of objects and the consistency of the data are important quality aspects of TOP10NL. Real world phenomena should be interpreted and represented in an unambiguous manner. Semantic changes are not preferred, but users will adjust their applications. These changes in semantics have consequences for the products derived from TOP10NL, but are limited because TOP10NL often is one of the input sources. Users also suggest to use multiple input sources for TOP10NL.

The conclusion of sub question two is:

The geometry and consistency of the data are more important than the exact content of attributes and attribute values. Information that is semantically changed due to derivation of BGT is not preferred.

8.2 Conclusion of the research

The main question of this thesis research was stated in section 1.3:
To what extend can TOP10NL fulfill the user expectations when BGT becomes the source?

The main goal of the Kadaster is to use BGT as source for TOP10NL. The research showed that TOP10NL and BGT are two different topographic products with their own purpose. TOP10NL will likely change with BGT as source due to all these differences. Users have stated that small changes in the meaning of information are not preferred. Important quality aspect for users are consistent data and geometry.

The final conclusion is:

BGT input may lead to a TOP10NL with different information, which is not preferred by users, but users expect a TOP10NL with consistent data and geometry.

8.3 Recommendations for related research

The Kadaster aims to derive TOP10NL from BGT using automated generalization. Three steps are distinguished in figure 2 to meet that goal. This researched focused on the first step and the users. The research gave some insight into the possible consequences for TOP10NL and users. More steps have to be set before TOP10NL can completely be derived from BGT. Further research is necessary and therefore some suggestions are proposed:

- Additional research is necessary to prove that TOP10NL content can be derived from BGT. This has to be proven with automated generalization. The work of Van Altena et al. (2013) is a first test. Automated generalization should prove that a solution can be found for the semantic and geometric differences that is acceptable for users. Some differences might even be overcome.
- An extended user consultation is necessary to find out if there is more information important for users. Bregt et al. (2013) showed that TOP10NL usage becomes more diverse. These new users are not represented in this research and could have a different opinion. It may also be possible that some TOP10NL information is unimportant. Some users suggested to add some information to TOP10NL. The extended user consultation can confirm these proposals and may even result in more suggestions. The extended user consultation may eventually lead to an update of information in TOP10NL that fits better with user needs.
- In this research BAG, BRK and AHN were proposed as potential sources. Research is necessary to find out if these sources are suitable to use in TOP10NL, because the purpose of these products is different and therefore their data is also different than the TOP10NL data. When information from different datasets is combined into TOP10NL two problems are partly solved: The amount of information that has to be surveyed is reduced and the information that TOP10NL offers is similar as the information in the source dataset. Furthermore, if it is possible to add information from BAG, BRK and AHN into TOP10NL automatically, then research can be done to find

more potential data sources for TOP10NL and transfer data from that dataset into TOP10NL.

- At the moment the information models of the small scale topographic datasets are integrated (Stoter et al., 2011). TOP10NL is the starting point for the integration of these datasets. A changed TOP10NL has consequences for the integration of the small scale information models and datasets. Separate research should find these consequences and present solutions.

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Afterword

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Appendix 1: UML model of BGT

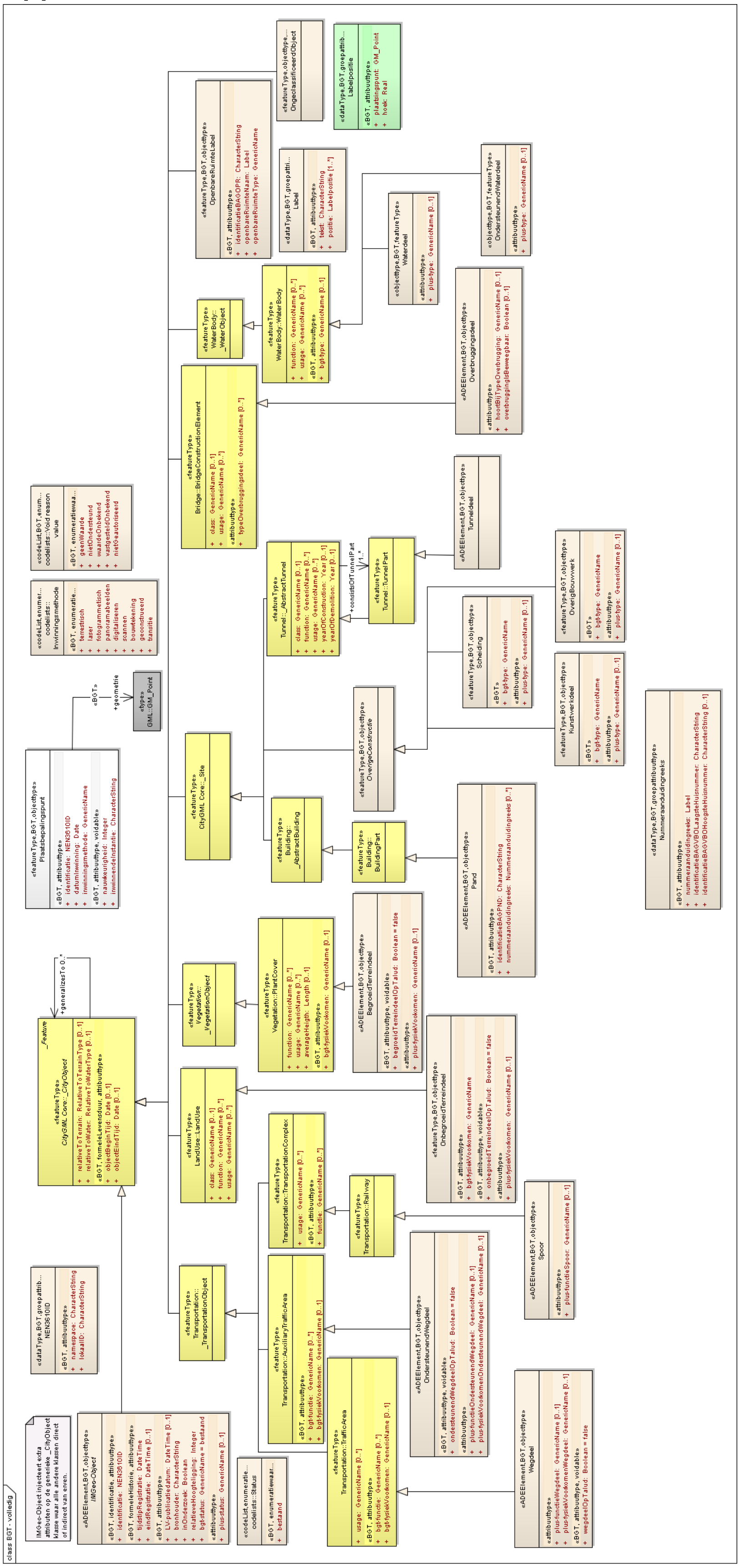

Figure A1: UML model of BGT
(Ministery of Infrastructure, 2012a)

Appendix 2: UML model of TOP10NL

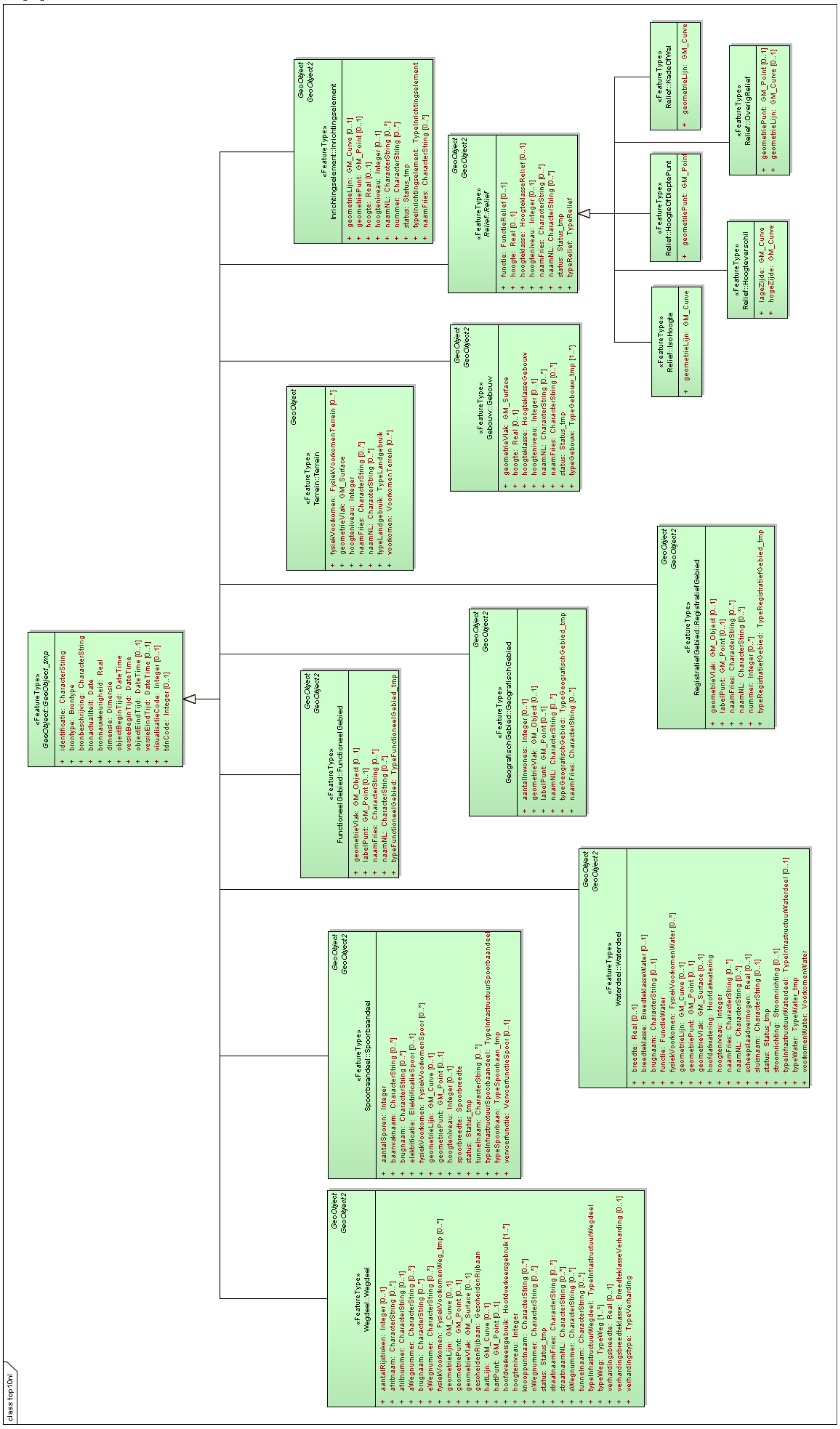

Figure A2: UML model of TOP10NL (Kadaster, 2013a)

Appendix 3: Table to compare BGT and TOP10NL

The table that is used to compare the attributes and attributes values of TOP10NL with BGT is presented here. This table belongs to step 1. The results of this step are provided in chapter 5. The table shows which BGT attributes and values can be matched with TOP10NL attributes and values. Each comparison results in a code. The colors are explained in table A3.

Table A1: Codes assigned to attributes

Code	Explanation
A1	BGT and TOP10NL attribute are similar
A2	Equivalent BGT and TOP10NL attribute contain different information due to different attribute values (schematic heterogeneity; Bishr 1998)
A3	BGT and TOP10NL attribute have a different definition (cognitive heterogeneity (Bishr 1998)
A4	TOP10NL attribute is found in BGT, but many information disappears
A5	TOP10NL attribute is not present in BGT, neither the information of the attribute

Table A2: Codes assigned to attribute values

Code	Explanation
V1	Attribute values are similar
V2	Attribute values are similar, but name is different (naming heterogeneity; Bishr 1998)
V3	Attribute value exits only in BGT, can be added to TOP10NL
V4	Attribute values have a different definition (cognitive heterogeneity; Bishr 1998)
V5	TOP10NL Attribute values are merged into a BGT attribute value (schematic heterogeneity; Bishr 1998)
V6	Attribute value is present but belongs to different attribute, resulting in loss of some information (schematic heterogeneity; Bishr 1998)
V7	TOP10NL Attribute value does not exist in BGT, Part of the information of the value can be derived from a semantically different value
V8	TOP10NL attribute value cannot be derived from BGT

Table A3: Explanation of the colors

Colour	Explanation
[Yellow]	Attribute can potentially be derived
[Red]	Attribute cannot be derived

Table A4: Comparison Table to match BGT and TOP10NL
TOP10NL object class: Wegdeel

TOP10NL Attribuut	TOP10NL Attribuut waarde	Semantiek	BGT Object klasse	BGT Attribuut	BGT 1.1 attribuut waarde	Opmerking
type infrastructuur	<algemeen>	A5				Semantisch niet af te leiden. Met GIS wel mogelijk
	verbinding	V8				
	kruising	V8				
	overig verkeersgebied	V8				
type weg	<algemeen>	A2	Wegdeel	functie		Indeling bij BGT verschilt van TOP10NL.
	autosnelweg	V1	Wegdeel	functie	"rijbaan autosnelweg"	Potentieel af te leiden
	hoofdweg	V7	Wegddel	functie	deels "rijbaan autoweg"	definitie "rijbaan autoweg" in BGT niet gelijk aan "hoofdweg" in TOP10NL. Zowel BGT "autoweg" als BGT "regionale weg"
	regionale weg	V4	Wegdeel	functie	"rijbaan regionale weg"	Definitieverschil
	lokale weg	V4, V5	Wegdeel	functie	"rijbaan lokale weg"	definitie 'lokale weg' in BRT en BGT niet gelijk. Onderscheid straat en lokale weg verdwijnt in BGT.
	straat	V7	Wegdeel	functie	"rijbaan lokale weg" en "woonerf"	TOP10NL "straat" voor groot deel onderdeel van 'rijbaan lokale weg' in BGT
	startbaan, landingsbaan	V5	Wegdeel	functie	"baan voor vlieg verkeer"	onderscheid tussen "startbaan, landingsbaan" en "rolbaan, platform" niet mogelijk
	rolbaan, platform	V5				
	overig	V3	Wegdeel	functie	"fietspad", "voetpad", "voetpad op trap", "ruiterpad", "voetgangersgebied", "parkeervlakken"	door samenvoegen potentieel af te leiden. Nieuwe BGT waarden kunnen hier toegevoegd worden als aparte waarde
			Wegdeel	functie	"spoorbaan"	gaat naar objectklasse Terrein
					'overweg"	Dient omgecodeerd te worden naar omliggend wegtype
					"OV-baan", "Inrit"	komt niet voor in huidige TOP10NL
hoofdverkeersgebruik	<algemeen>	A2	Wegdeel	functie		Belangrijkste waarden potentieel af te leiden, maar afhankelijk van samenvoegingen. Veel waarden kunnen toegevoegd worden aan Type weg
	snelverkeer	V7	Wegdeel	functie	"rijbaan autoweg" en "rijbaan autosnelweg"	Potentieel af te leiden. Moeilijk af te leiden voor regionale wegen met vrijliggend fietspad.
	gemengd verkeer	V7	Wegdeel	functie	"rijbaan regionale weg", "rijbaan lokale weg" en "woonerf",	Regionale weg kan zowel gemengd als snelverkeer zijn. Onderscheid is moeilijk te bepalen
	busverkeer	V4	Wegdeel	functie	OV-baan	Potentieel af te leiden, maar inclusief trambanen.

	fietsers, bromfietsers	V2	Wegdeel	functie	fietspad	Potentieel af te leiden
	voetgangers	V2	Wegdeel	functie	voetgangersgebied	Potentieel af te leiden
	ruiters	V2	Wegdeel	functie	ruiterpad	Potentieel af te leiden
	vliegverkeer	V2	Wegdeel	functie	baan voor vliegverkeer	Potentieel af te leiden
	parkeren	V5	Wegdeel	functie	parkeervlak	Potentieel af te leiden, maar inclusief carpoolplaats en P+R plaats
	parkeren: carpoolplaats	V8				niet af te leiden; onderscheid in parkeervlak niet mogelijk
	parkeren: P+R parkeerplaats	V8				
	overig	V8				niet af te leiden
fysiek Voorkomen	<algemeen>	A2	Overbruggingsdeel; Tunneldeel			Meeste waarden fysiekVoorkomen zijn potentieel af te leiden
	op vast deel van de brug	V5	Overbruggingsdeel	n.v.t	n.v.t	in BGT -geen onderverdeling in vast deel, beweegbaar deel
	op beweegbaar deel van de brug	V5				
	overkluisd	V8				Niet af te leiden
	in tunnel	V1	Tunneldeel	n.v.t.	n.v.t	potentieel af te leiden via ruimtelijke overlay. Gelijke semantiek
	als veer/pont	V8				niet af te leiden
verhardingsbreedte-klasse	<algemeen>	A5				Semantisch niet af te leiden, maar wel met GIS berekening
	> 7 meter	V8				
	4 - 7 meter	V8				
	2 -4 meter	V8				
	< 2 meter	V8				
verhardingsbreedte	n.v.t.	A5				Semantisch niet af te leiden, maar wel met GIS berekening
verhardingstype	<algemeen>	A1	Wegdeel	fysiekVoorkomen		Potentieel af te leiden
	verhard	V3	Wegdeel	fysiekVoorkomen	gesloten +open verharding	Potentieel af te leiden
	half verhard	V1	Wegdeel	fysiekVoorkomen	half verhard	Potentieel af te leiden
	onverhard	V1	Wegdeel	fysiekVoorkomen	onverhard	Potentieel af te leiden
gescheiden rijbaan	<algemeen>	A5				niet af te leiden
	ja	V8				niet af te leiden
	nee	V8				niet af te leiden
aantal rijstroken	n.v.t.	A5				niet af te leiden
status	<algemeen>	A4	IMGeo-Object	status		In BGT alleen Status = "bestaand"
	realisatie: nog niet in uitvoering	V8				

	realisatie: in uitvoering	V8				
	in gebruik	V5	IMGeo-Object	status	bestaand	In BGT geen onderscheid tussen "in gebruik" en "buiten gebruik"
	buiten gebruik	V5				
straatnaam (Nl)	n.v.t.	A4	Openbare Ruimte Label	openbare Ruimte Naam		Alleen Openbare ruimte die opgenomen is in BAG. Labels liggen niet altijd binnen het wegdeel object. Input uit BAG.
Straatnaam (Fr)		A4	Openbare Ruimte Label	openbare Ruimte Naam		
A-wegnummer		A5				niet af te leiden
N-wegnummer		A5				niet af te leiden
E-wegnummer		A5				niet af te leiden
S-wegnummer		A5				niet af te leiden
afritnummer	n.v.t.	A5				niet af te leiden
afritnaam	n.v.t.	A5				niet af te leiden
knooppunt naam	n.v.t.	A5				niet af te leiden
brugnaam	n.v.t.	A4				Mogelijk af te leiden uit OpenbareRuimteLabels, maar niet bij elke brug
tunnelnaam	n.v.t.	A4				Mogelijk af te leiden uit OpenbareRuimteLabels, maar niet bij elke tunnel
hoogteniveau	n.v.t.	A3	IMGeo_object	relatieve Hoogte Ligging		Definitieverschil

TOP10NL object class: spoor

TOP10NL Attribuut	**TOP10NL Attribuut waarde**	**Semantiek**	**BGT Object klasse**	**BGT Attribuut**	**BGT Attribuut waarde**	**Opmerking**
type infrastructuur	<algemeen>	A5	Spoor	n.v.t		Semantisch is het niet af te leiden, maar wel met GIS
	verbinding	V8				
	kruising	V8				
type spoorbaan	<algemeen>	A2	Spoor	functie		Potentieel af te leiden
	trein	V1	Spoor	functie	trein	Potentieel af te leiden
	tram	V1	Spoor	functie	tram	Potentieel af te leiden
	metro	V4	Spoor	functie	sneltram	definitieverschil
	gemengd	V8				niet af te leiden.
fysiek voorkomen	<algemeen>	A2	Overbruggingsdeel; Tunneldeel	n.v.t.		Potentieel af te leiden
	op vast deel van brug	V5	Overbruggingsdeel	n.v.t	n.v.t	Onderscheid gaat verloren
	op beweegbaar deel van brug	V5				
	overkluisd	V8				Niet af te leiden
	in tunnel	V1	Tunneldeel	n.v.t.	n.v.t	Potentieel af te leiden via ruimtelijke overlay. Gelijke semantiek
spoorbreedte	<algemeen>	A5				niet af te leiden
	normaalspoor	V8				niet af te leiden
	smalspoor	V8				niet af te leiden

	gemengd	V8				niet af te leiden
aantal sporen	n.v.t.	A5	Spoor	Functie		Sematische afleiding niet mogelijk, Met behulp van GIS operaties wel af te leiden
vervoerfunctie	<algemeen>	A5				niet af te leiden
	gemengd gebruik	V8				niet af te leiden
	personenvervoer	V8				niet af te leiden
	goederenvervoer	V8				niet af te leiden
	museumlijn	V8				niet af te leiden
elektrificatie	<algemeen>	A5				niet af te leiden
	geëlektrificeerd,	V8				niet af te leiden
	niet geëlektrificeerd,	V8				niet af te leiden
	gemengd	V8				niet af te leiden
status	<algemeen>	A4				In BGT alleen Status = "bestaand"
	realisatie: nog niet in uitvoering	V8				
	realisatie: in uitvoering	V8				
	in gebruik	V5	IMGeo-Object	status	bestaand	In BGT geen onderscheid tussen "in gebruik" en "buiten gebruik"
	buiten gebruik	V5				
baanvaknaam	< naam baanvak >	A5				Niet af te leiden
brugnaam	n.v.t.	A4				Mogelijk af te leiden uit OpenbareRuimteLabels, maar niet bij elke brug
tunnelnaam	n.v.t.	A4				Mogelijk af te leiden uit OpenbareRuimteLabels, maar niet bij elke tunnel
hoogteniveau	n.v.t.	A3	IMGeo_object	relatieve Hoogte Ligging		Definitieverschil

TOP10NL object class: Waterdeel

TOP10NL Attribuut	**TOP10NL Attribuut waarde**	**Semantiek**	**BGT Object klasse**	**BGT Attribuut**	**BGT 1.1 Attribuut waarde**	**Opmerking**
type infrastructuur	<algemeen>	A5				Niet af te leiden
	kruising	V8				Niet af te leiden
	verbinding	V8				Niet af te leiden
	overig watergebied	V8				Niet af te leiden
type water	<algemeen>	A2				Potentieel af te leiden, maar BGT object oever moet gesplitst en samengevoegd worden met omliggende objecten
	waterloop	V1	Waterdeel	type	waterloop	Potentieel af te leiden.
	meer, plas, ven, vijver	V4	Waterdeel	type	watervlakte, oever	Het is onduidelijk of zeehavens in de BGT als watervlakte of als zee getypeerd worden. Op basis van BGT definitie ligt de grens op grensvlak zoet-zout.
	greppel, droge sloot	V1	Waterdeel	type	greppel, droge sloot	Potentieel af te leiden

	zee	V4	Waterdeel	type	zee	Potentieel af te leiden; grens tussen water en terrein is echter verschillend tussen BGT en TOP10NL.
	droogvallend	V4	Onderste unend waterdeel	type	slik oever	Waarschijnlijk af te leiden; 'slik' alleen in Waddenzee en Zuid-westelijke delta; 'oever' mogelijk aanwezig langs kust Noordzee.
	bron, wel	V8				Niet af te leiden
breedte klasse	<algemeen>	A5				
	0,5 - 3 meter	V8				
	3 tot 6 meter	V8				
	> 6 meter	V8				
breedte		A5				Semantisch niet af te leiden
hoofd afwatering	<algemeen>	A5				Niet af te leiden
	ja	V8				
	nee	V8				
fysiek Voorkomen	<algemeen>	A4				Sommige waarden zijn mogelijk af te leiden via ruimtelijke overlay
	in sluis	V1	Kunstwer kdeel	type	sluis	Potentieel af te leiden via ruimtelijke overlay.
	op brug	V1	Overbrug gingsdeel	n.v.t	n.v.t	Potentieel af te leiden via ruimtelijke overlay.
	in duiker	V8				Niet af te leiden
	in afsluitbare duiker	V8				Niet af te leiden
	in grondduiker	V8				Niet af te leiden
	in afsluitbare grondduiker	V8				Niet af te leiden
	overkluisd	V8				Niet af te leiden
functie	<algemeen>	A5				Vrijwel niet af te leiden
	Drinkwaterbe kken	V8				Niet af te leiden
	haven	V8				Niet af te leiden
	natuurbad	V8				Niet af te leiden
	viskwekerij	V8				Niet af te leiden
	vistrap	V8				Niet af te leiden
	vloeiveld	V8				Niet af te leiden
	waterval	V8				Niet af te leiden
	waterzuiverin g	V7	OverigBo uwwerk	type	bezinkbak	BGT bezinkbak is onderdeel van BRT waterzuivering
	zwembad	V7	OverigBo uwwerk	type	bassin	BGT 'bassin' wordt ook voor andere waterbakken gebruikt zoals dok. Informatie is aanwezig maar moeilijk af te leiden tot TOP10NL attribuut.
	overig	V8				Niet af te leiden
voorkomen	<algemeen>	A5				Niet af te leiden.
	met riet	V8				Niet af te leiden.
	overig	V8				Niet af te leiden.
stroom richting	<algemeen>	A5				Niet af te leiden
	eenrichting	V8				Niet af te leiden
	stilstaand	V8				Niet af te leiden
	getijdeinvloed	V8				Niet af te leiden
scheepslaad vermogen		A5				Niet af te leiden
status	<algemeen>	A4				In BGT alleen Status = "bestaand"
	realisatie: nog niet in	V8				

	uitvoering					
	realisatie: in uitvoering	V8				
	in gebruik	V5	IMGeo-Object	status	bestaand	In BGT geen onderscheid tussen "in gebruik" en "buiten gebruik"
	buiten gebruik	V5				
naam (Nl)		A4	OpenbareRuimteLabel	openbareRuimteNaam		Alleen Openbare ruimte die opgenomen is in BAG.
naam (fr)		A4	OpenbareRuimteLabel	openbareRuimteNaam		Alleen Openbare ruimte die opgenomen is in BAG.
sluisnaam		A4				Mogelijk af te leiden uit OpenbareRuimteLabels
brugnaam		A4				Mogelijk af te leiden uit OpenbareRuimteLabels
hoogteniveau		A3	IMGeo_object	relatieveHoogteLigging		Definitieverschil

TOP10NL object class: Terrein

TOP10NL Attribuut	TOP10NL Attribuut waarde	Semantiek	BGT Object klasse	BGT Attribuut	BGT Attribuut waarde	Opmerking
type landgebruik	<algemeen>	A2		fysiek Voorkomen	<algemeen>	Merendeel waarden potentieel af te leiden. Er treedt wel informatieverandering op
	aanlegsteiger	V2	Kunstwerkdeel	type	steiger	naam verschilt
	akkerland	V2	Begroeid Terreindeel	fysiek Voorkomen	bouwland	naam verschilt
	basaltblokken, steenglooiing	V2	Kunstwerkdeel	type	strekdam	naam verschilt
	bebouwd gebied	V8				
	boomgaard	V5	Begroeid Terreindeel	fysiek Voorkomen	fruitteelt	Boomgaard en fruitteelt zijn samengevoegd in BGT
	boomkwekerij	V2	Begroeid Terreindeel	fysiek Voorkomen	boomteelt	naam verschilt
	bos: gemengd bos	V1	Begroeid Terreindeel	fysiek Voorkomen	gemengd bos	
	bos: griend	V5	Begroeid Terreindeel	fysiek Voorkomen	loofbos	griend is onderdeel van BGT 'loofbos'.
	bos: loofbos	V5	Begroeid Terreindeel	fysiek Voorkomen	loofbos, houtwal	af te leiden, maar BGT omvat ook griend en populieren
	bos: naaldbos	V1	Begroeid terreindeel	fysiek Voorkomen	naaldbos	
	dodenakker	V8				niet af te leiden.
	dodenakker met bos	V8				niet af te leiden.
	fruitkwekerij	V5	Begroeid Terreindeel	fysiek Voorkomen	fruitteelt	Boomgaard en fruitteelt zijn samengevoegd in BGT
	grasland	V3	Begroeid Terreindeel	fysiek Voorkomen	grasland agrarisch, grasland overig	
	heide	V1	Begroeid Terreindeel	fysiek Voorkomen	heide	
	laadperron	V4	Kunstwerkdeel	type	perron	definitieverschil
	populieren	V5	Begroeid terreindeel	fysiek Voorkomen	loofbos	populieren' is onderdeel van BGT 'loofbos'.
	spoorbaanlichaam	V2	Wegdeel	functie	spoorbaan	naam verschilt

	zand	V1	Onbegroeid Terreindeel	fysiek Voorkomen	zand	
	overig	V3			groenvoorziening; duin; kwelder, struiken	overige attribuutwaarden in BGT fysiek voorkomen Begroeid Terrein. Zouden aan TOP10NL toegevoegd kunnen worden
fysiek voorkomen	<algemeen>	A2				Attribuut bestaat in BGT uit verschillene objectklassen
	overkluisd	V8				
	in tunnel	V1	Tunneldeel			
	op brug	V2	Overbruggingsdeel			
voorkomen	<algemeen>	A2				Waarden aanwezig in BGT, maar niet in een apart attribuut. Hierdoor zal informatie verdwijnen.
	met riet	V6	Begroeid Terreindeel	fysiek Voorkomen	rietland	
	dras, moerassig	V6	Begroeid Terreindeel	fysiek Voorkomen	moeras	
naam (Nl)	n.v.t.	A4				Mogelijk af te leiden uit OpenbareRuimteLabels
naam (fr)	n.v.t.	A4				
hoogte niveau	n.v.t.	A3	IMGeo_ object	relatieve Hoogte Ligging		Definitieverschil

TOP10NL object class:Gebouw

TOP10NL Attribuut	**TOP10NL Attribuut waarde**	**Semantiek**	**BGT Object klasse**	**BGT Attribuut**	**BGT Attribuut waarde**	**Opmerking**
type gebouw	<algemeen>	A5				Veel gebouw typen zijn niet af te leiden
	brandtoren	V8				niet af te leiden
	bezoekerscentrum	V8				niet af te leiden
	bunker	V8				niet af te leiden
	crematorium	V8				niet af te leiden
	deelraadsecretarie	V8				niet af te leiden
	dok	V8				niet af te leiden
	elektriciteitscentrale	V8				niet af te leiden
	fabriek	V8				niet af te leiden
	fort	V8				niet af te leiden
	gascompressiestation	V8				niet af te leiden
	gemaal	V1	Kunstwerkdeel	type	gemaal	potentieel af te leiden
	gemeentehuis	V8				niet af te leiden
	gevangenis	V8				niet af te leiden
	grenskantoor	V8				niet af te leiden
	hotel	V8				niet af te leiden
	huizenblok	V8				niet af te leiden
	hulpsecretarie	V8				niet af te leiden
	kapel	V8				niet af te leiden
	kas, warenhuis	V8				niet af te leiden
	kasteel	V8				niet af te leiden
	kerk	V8				niet af te leiden
	kerncentrale, kernreactor	V8				niet af te leiden
	kliniek, inrichting, sanatorium	V8				niet af te leiden
	klokkentoren	V8				niet af te leiden
	klooster, abdij	V8				niet af te leiden
	koeltoren	V8				niet af te leiden
	koepel	V8				niet af te leiden
	kunstijsbaan	V8				niet af te leiden
	lichttoren	V8				niet af te leiden
	luchtwachttoren	V8				niet af te leiden
	manege	V8				niet af te leiden
	metrostation	V8				niet af te leiden
	militair gebouw	V8				niet af te leiden
	motel	V8				niet af te leiden

	museum	V8				niet af te leiden
	parkeerdak, parkeerdek, parkeergarage	V8				niet af te leiden
	peilmeetstation	V8				niet af te leiden
	politiebureau	V8				niet af te leiden
	pompstation	V8				niet af te leiden
	postkantoor	V8				niet af te leiden
	psychiatrisch ziekenhuis, psychiatrisch centrum	V8				niet af te leiden
	radarpost	V8				niet af te leiden
	radartoren	V8				niet af te leiden
	radiotoren, televisietoren	V8				niet af te leiden
	recreatiecentrum	V8				niet af te leiden
	reddingboothuisje	V8				niet af te leiden
	reddinghuisje, schuilhut	V8				niet af te leiden
	religieus gebouw	V8				niet af te leiden
	remise	V8				niet af te leiden
	ruïne	V8				niet af te leiden
	schaapskooi	V8				niet af te leiden
	school	V8				niet af te leiden
	schoorsteen	V8				niet af te leiden
	sporthal	V8				niet af te leiden
	stadion	V8				niet af te leiden
	stadskantoor	V8				niet af te leiden
	tank	V2	Overig Bouwwerk	type	opslagtank	potentieel af te leiden
	tankstation	V8				niet af te leiden
	telecommunicatietoren	V8				niet af te leiden
	toren	V8				niet af te leiden
	transformatorstation	V2	Overig Bouwwerk	type	lage trafo	potentieel af te leiden
	treinstation	V8				niet af te leiden
	uitzichttoren	V8				niet af te leiden
	universiteit	V8				niet af te leiden
	veiling	V8				niet af te leiden
	verkeerstoren	V8				niet af te leiden
	vuurtoren	V8				niet af te leiden
	waterradmolen	V8				niet af te leiden
	watertoren	V8				niet af te leiden
	wegenwachtstation	V8				niet af te leiden
	wegrestaurant	V8				niet af te leiden
	werf	V8				niet af te leiden
	windmolen	V8				niet af te leiden
	windmolen: korenmolen	V8				niet af te leiden
	windmolen: watermolen	V8				niet af te leiden
	windturbine	V1	Overig Bouwwerk	type	windturbine	gaat naar inrichtingselement
	zendtoren	V8				niet af te leiden
	ziekenhuis	V8				niet af te leiden
	zwembad	V7	Overig Bouwwerk	type	bassin	Bevat ook dokken.
	overig	V7	Pand	n.v.t		alle panden vallen binnen "overig"; onderverdeling naar type is niet mogelijk
hoogteklasse	<algemeen>	A5				niet af te leiden
	laagbouw	v8				niet af te leiden
	hoogbouw	v8				niet af te leiden
status	<algemeen>	A4				In BGT alleen Status = "bestaand"
	realisatie: nog niet in uitvoering	V8				

	realisatie: in uitvoering	V8				
	in gebruik	V5	IMGeo-Object	status	bestaand	In BGT geen onderscheid tussen "in gebruik" en "buiten gebruik"
	buiten gebruik	V5				
hoogte	n.v.t.	A5				niet af te leiden
hoogteniveau	n.v.t	A3	IMGeo_ object	relatieve Hoogte Ligging		Definitieverschil
naam (Nl)	n.v.t.	A5				niet af te leiden
naam (fr)	n.v.t.	A5				niet af te leiden

TOP10NL object class: Inrichtingselement

TOP10NL Attribuut	TOP10NL Attribuut waarde	Seman tiek	BGT Object klasse	BGT Attribuut	BGT Attribuut waarde	Opmerking
type inrichtings element	<algemeen>	A5				veel waarden niet af te leiden
	aanlegsteiger	V2	Kunstwerkdeel	type	steiger	Grote steigers (breder dan 2 meter) worden onderdeel van terrein. Kleine steigers worden lijnelementen
	baak	V8				niet af te leiden
	bomenrij	V7	Fysiek voorkomen	Begroeid terrein	Houtwal	Kan ook weergegeven worden als heg.
	boom	V8				niet af te leiden
	boorput	V8				niet af te leiden
	boortoren	V8				niet af te leiden
	BOS-pomp	V8				niet af te leiden
	brandtoren	V8				niet af te leiden
	dam, koedam	V8				niet af te leiden
	dukdalf	V8				niet af te leiden
	gaswinning	V8				niet af te leiden
	gedenkteken, monument	V8				niet af te leiden
	geluidswering	V2	Scheiding	type	geluids scherm	potentieel af te leiden,
	gemaal	V1	Kunstwerk deel	type	gemaal	potentieel af te leiden; ook als gebouw op te nemen. Omzetten naar puntgeometrie
	golfmeetpaal	V8				niet af te leiden
	GPS kernnetpunt	V8				niet af te leiden
	grenspunt	V8				niet af te leiden
	heg, haag	V7	Fysiek voorkomen	Begroeid terrein	Houtwal	kan ook als bomenrij afgeleid worden.
	hekwerk	V2	Scheiding	type	hek	potentieel af te leiden; maar waarschijnlijk is niet elk hek relevant voor TOP10NL
	helikopterlanding splatform	V8				niet af te leiden
	hoogspanningslei ding	V8				niet af te leiden
	hoogspanningsm ast	V1	Kunstwerk deel	type	hoog spannings mast	potentieel af te leiden. Vlakken omzetten naar punten
	hunebed	V8				niet af te leiden
	kaap	V8				niet af te leiden
	kabelbaan	V8				niet af te leiden
	kabelbaanmast	V8				niet af te leiden
	kapel	V8				niet af te leiden
	kilometerpaal	V8				niet af te leiden
	kilometerpaal	V8				niet af te leiden

	spoorweg					
	kilometerpaal water	V8				niet af te leiden
	kilometerraaibord	V8				niet af te leiden
	kilometerraaipaal	V8				niet af te leiden
	koeltoren	V8				niet af te leiden
	koepel	V8				niet af te leiden
	kogelvanger schietbaan	V8				niet af te leiden
	kraan	V8				niet af te leiden
	kruis	V8				niet af te leiden
	laadperron	V4	Kunstwerkdeel	type	perron	zowel passagiers als goederenperron
	leiding	V8				niet af te leiden
	licht, lichtopstand	V8				niet af te leiden
	lichttoren	V8				niet af te leiden
	luchtvaartlicht	V8				niet af te leiden
	markant object	V8				niet af te leiden
	muur	V1	Scheiding	type	muur	potentieel af te leiden; maar waarschijnlijk is niet elke muur relevant voor TOP10NL
	oliepompinstallatie	V8				niet af te leiden
	paal	V8				niet af te leiden
	paalwerk	V8				niet af te leiden
	peilmeetstation	V8				niet af te leiden
	peilschaal	V8				niet af te leiden
	pijler	V8				niet af te leiden
	radarpost	V8				niet af te leiden
	radiobaken	V8				niet af te leiden
	radiotelescoop	V8				niet af te leiden
	RD punt	V8				niet af te leiden
	schietbaan	V8				niet af te leiden
	schoorsteen	V8				niet af te leiden
	seinmast	V8				niet af te leiden
	sluisdeur	V8				niet af te leiden
	station	V8				niet af te leiden
	stormvloedkering	V8				niet af te leiden
	strandpaal	V8				niet af te leiden
	strekdam, krib, golfbreker	V2	Kunstwerk deel	type	strekdam	potentieel af te leiden; ook als terrein op te nemen
	stuw	V8				niet af te leiden
	tol	V8				niet af te leiden
	toren	V8				niet af te leiden
	uitzichttoren	V8				niet af te leiden
	verkeersgeleider	V8				niet af te leiden
	visplaats	V8				niet af te leiden
	vlampijp	V8				niet af te leiden
	wegafsluiting	V8				niet af te leiden
	wegwijzer	V8				niet af te leiden
	windmolen	V8				niet af te leiden
	windmolen: korenmolen	V8				niet af te leiden
	windmolen: watermolen	V8				niet af te leiden
	windmolentje	V8				niet af te leiden
	windturbine	V1	Overig Bouwwerk	type	windturbine	potentieel af te leiden
	zeevaartlicht	V8				niet af te leiden
	zendmast	V8				niet af te leiden
	zichtbaar wrak	V8				niet af te leiden
naam (Nl)	n.v.t.	A4				Mogelijk af te leiden uit OpenbareRuimteLabels
naam (fr)	n.v.t.	A4				
nummer		A5				Niet af te leiden
Hoogte		A5				Niet af te leiden
hoogteniveau	n.v.t	A3	IMGeo_ object	relatieve Hoogte		Definitieverschil

				Ligging		
status	<algemeen>	A4				In BGT alleen Status = "bestaand"
	realisatie: nog niet in uitvoering	V8				niet af te leiden, maar wordt in BRT niet gebruikt
	realisatie: in uitvoering	V8				
	in gebruik	V5	IMGeo-Object	status	bestaand	In BGT geen onderscheid tussen "in gebruik" en "buiten gebruik"
	buiten gebruik	V5				

TOP10NL object class: Relief

TOP10NL Attribuut	TOP10NL Attribuut waarde	Seman tiek	BGT Object klasse	BGT Attribuut	BGT Attribuut waarde	Opmerking
type reliëf	<algemeen>	A4				beperkt deel is mogelijk af te leiden
	kade, wal	V7	Scheiding	type	kademuur walbescher ming	Verschil in definitie, kades lijken niet vanuit BGT af te leiden
	talud, hoogteverschil	V7	Begroeid Terreindeel; Onbegroeid Terreindeel; Wegdeel;	op talud;	ja/nee	alleen Talud is af te leiden, maar TOP10NL object bestaat uit de hoge en de uit de lage zijde van het talud en niet de gehele helling.
	steile rand, aardrand	V8				Niet af te leiden
	dieptelijn	V8				niet af te leiden
	dieptepunt	V8				niet af te leiden
	hoogtelijn	V8				niet af te leiden
	hoogtepunt	V8				niet af te leiden
	laagwaterlijn	V8				niet af te leiden
	peil	V8				niet af te leiden
	peil: winterpeil	V8				niet af te leiden
	peil: zomerpeil	V8				niet af te leiden
hoogteklass e	<algemeen>	A5				Niet af te leiden
	1 - 2,5 meter	V8				
	> 2,5 meter	V8				
	> 1 meter	V8				
hoogte	n.v.t.	A5				Niet af te leiden
functie	<algemeen>	A1				potentieel af te leiden
	geluid weren	V6	scheiding	type	geluidssche rm	geluidscherm is in BGT een apart object, waardoor het moeilijk te combineren is met het type reliëf
	waterkering	V3	functioneel gebied	type	waterkering	potentieel af te leiden
naam (Nl)		A5				Niet af te leiden
naam (fr)		A5				Niet af te leiden
status	<algemeen>	A4				Potentieel is een gedeelte af te leiden
	realisatie: nog niet in uitvoering	V8				niet af te leiden
	realisatie: in uitvoering	V8				niet af te leiden
	in gebruik	V5	IMGeo-Object	status	bestaand	In BGT geen onderscheid tussen "in gebruik" en "buiten gebruik"
	buiten gebruik	V5				
hoogtenive au	n.v.t	A3	IMGeo_ object	relatieve Hoogte Ligging		Definitieverschil

TOP10NL object class: Functioneel gebied

TOP10NL Attribuut	TOP10NL Attribuut waarde	Semantiek	BGT Object klasse	BGT Attribuut	BGT Attribuut waarde	Opmerking
type functioneel gebied	<algemeen>	A5				Vrijwel niet af te leiden.
	arboretum	V8				niet af te leiden.
	bedrijventerrein	V8				niet af te leiden
	begraafplaats	V8				niet af te leiden
	boswachterij	V8				niet af te leiden
	bungalowpark	V8				niet af te leiden
	camping, kampeerterrein	V8				niet af te leiden
	caravanpark	V8				niet af te leiden
	circuit	V8				niet af te leiden
	crossbaan	V8				niet af te leiden
	dierentuin, safaripark	V8				niet af te leiden
	eendenkooi	V8				niet af te leiden
	emplacement	V8				niet af te leiden
	erebegraafplaats	V8				niet af te leiden
	gaswinning	V8				niet af te leiden
	gebied met hoge objecten	V8				niet af te leiden
	gebouwencomplex	V8				niet af te leiden
	golfterrein	V8				niet af te leiden
	grafheuvel	V8				niet af te leiden
	grindwinning	V8				niet af te leiden
	groeve	V8				niet af te leiden
	haven	V8				niet af te leiden
	heemtuin	V8				niet af te leiden
	helikopterlandings terrein	V8				niet af te leiden
	infiltratiegebied	V8				niet af te leiden
	Jachthaven	V8				Niet af te leiden
	kartingbaan	V8				niet af te leiden
	kazerne, legerplaats	V8				niet af te leiden
	landgoed	V8				niet af te leiden
	mijn	V8				niet af te leiden
	mijnsteenberg	V8				niet af te leiden
	militair oefengebied, schietterrein	V8				niet af te leiden
	mosselbank	V8				niet af te leiden
	natuurgebied, natuurreservaat	V8				niet af te leiden
	oliewinning	V8				niet af te leiden
	openluchtmuseum	V8				niet af te leiden
	openluchttheater	V8				niet af te leiden
	park	V8				niet af te leiden
	pinetum	V8				niet af te leiden
	plantsoen	V2	Begroeid Terreindeel	fysiekVoorkomen	groen voorziening	omzetten van vlak naar punt
	productie-installatie	V8				niet af te leiden
	recreatiegebied	V8				niet af te leiden
	renbaan	V8				niet af te leiden
	skibaan	V8				niet af te leiden
	slipschool	V8				niet af te leiden
	sluizencomplex	V8				niet af te leiden
	sportterrein, sportcomplex	V8				niet af te leiden
	stortplaats	V8				niet af te leiden
	tankbaan	V8				niet af te leiden
	tennispark	V8				niet af te leiden
	transformatorstation	V2	Overig Bouwwerk	type	lage trafo	omzetten van vlak naar punt
	tuincentrum	V8				niet af te leiden
	verzorgingsplaats	V8				niet af te leiden
	viskwekerij	V8				niet af te leiden
	vliegveld,	V8				niet af te leiden

	luchthaven					
	volkstuinen	V8				niet af te leiden
	werf	V8				niet af te leiden
	wildwissel	V8				niet af te leiden
	windturbinepark	V8				niet af te leiden
	woonwagencentrum	V8				niet af te leiden
	ijsbaan	V8				niet af te leiden
	zandwinning	V8				niet af te leiden
	zenderpark	V8				niet af te leiden
	zoutwinning	V8				niet af te leiden
	zuiveringsinstallatie	V8				niet af te leiden
	zweefvliegveldterrei n	V8				niet af te leiden
	zwembad complex	V7	Overig Bouwwerk	type	bassin	Onderdeel van bassin. Alleen puntgeometrie kan afgeleid worden
	overig	V3	functioneel gebied	type	kering	BGT type dat niet in TOP10NL zit.
naam (Nl)	n.v.t.	A5				niet af te leiden
naam (fr)	n.v.t.	A5				niet af te leiden

TOP10NL object class: registratief gebied

TOP10NL Attribuut	TOP10NL Attribuut waarde	semantiek	BGT Object klasse	BGT Attribuut	BGT Attribuut waarde	Opmerking
type registratief gebied	<algemeen>	A5				BGT kent geen objectklasse RegistratiefGebied.
	land	V8				Niet af te leiden.
	provincie	V8				Niet af te leiden.
	gemeente	V8				Niet af te leiden.
	stadsdeel	V8				Niet af te leiden
	wijk	V8				Niet af te leiden
	buurt	V8				Niet af te leiden
	waterschap	V8				Niet af te leiden
	nationaal park	V8				Niet af te leiden
	Bundesland	V8				Niet af te leiden
	Regierungsbezirk	V8				Niet af te leiden
	Kreis	V8				Niet af te leiden
naam (Nl)	n.v.t.	A5				Niet af te leiden
naam (fr)	n.v.t.	A5				Niet af te ledien
nummer	n.v.t.	A5				Niet af te leiden

TOP10NL object class: Geografisch gebied

TOP10NL Attribuut	TOP10NL Attribuut waarde	Semant iek	BGT Object klasse	BGT Attribuut	BGT Attribuut waarde	Opmerking
type geografisch gebied	<algemeen>	A5				Niet af te leiden
	bank, ondiepte, plaat	V8				Niet af te leiden
	bosgebied	V1	Begroeid terrein	type	gemengd bos, naaldbos, loofbos	Samenvoegen van verschillende bosgebieden.
	buurtschap	V8				Niet af te leiden
	duingebied	V2	Begroeid terrein	type	duin	Potentieel af te leiden
	eiland	V8				Niet af te leiden
	geul, vaargeul	V8				Niet af te leiden
	heidegebied	V2	Begroeid terrein	type	heide	Potentieel af te leiden
	heuvel, berg	V8				Niet af te leiden
	huizengroep	V8				Niet af te leiden
	kaap, hoek	V8				Niet af te leiden
	meer, plas, ven, vijver	V8				Niet af te leiden
	plaats, bewoond oord	V8				Niet af te leiden
	polder	V8				Niet af te leiden
	streek, veld	V8				Niet af te leiden

	terp	V8				Niet af te leiden
	vliedberg	V8				Niet af te leiden
	wad	V8				Niet af te leiden
	woonwijk	V8				Niet af te leiden
	Zee	V1	Waterdeel	Type	Zee	Af te leiden
	zeegat, zeearm	V8				Niet af te leiden
	overig	V8				Niet af te leiden
aantal inwoners	n.v.t.	A5				Niet af te leiden
naam (Nl)	n.v.t.	A5				Niet af te leiden
naam Fr)	n.v.t.	A5				Niet af te leiden