GIMA
Geographical Information Management and Applications

Crowdsourcing toponymic data in the Netherlands

Defining methods, rules and regulations for the registration of objects and names in national mapping

Jasper Hogerwerf
jasper.hogerwerf@kadaster.nl

Supervisors:
dr.ir. Rob Lemmens
prof.dr. Ferjan Ormeling

Responsible professor:
prof.dr. Menno-Jan Kraak

July 2018

Illustration cover page: Playful protest against the placement of an informative and promotive sign indicating the supposed entrance to the Achterhoek region along the Oud Arnhemseweg between the villages of Babberich and Beek, in a region known as Liemers. The text on the yellow sticker reads "Liemers Annexed area!" (Omroep Gelderland 2015). The demarcation of the Achterhoek region by the authorities is clearly not consistent with that of the inhabitants of this region. The sign was removed soon afterwards.

Summary

For more than 200 years, geographical names have been a prominent and indispensable part of national mapping in the Netherlands. Yet, shortly after the Topographic Survey became part of Kadaster and the topographic databases and maps were given a legal basis as the Key Register of Topography (BRT), in 2009 the time-consuming field work activities that served as the main source for toponymic data were discontinued. Geographical names however, cannot be seen from aerial images and most names do not appear on or are legible from street view images either. As a result, large parts of these data could not be maintained any more, despite the legal obligation to do so.

Following the principle 'collect once, use many times', Kadaster increasingly uses existing external data sets as a source for BRT data. Some of these contain toponymic data and are a suitable source to maintain some names categories in the BRT. This applies in particular to governmental data, such as street names and populated place names in the Key Register of Addresses and Buildings (BAG) and off-shore water names on nautical maps of the Hydrographic Service. For other names categories however, there are no sources available that meet the temporal accuracy and quality requirements for key registers like the BRT. This applies for example to many building names and area names.

The past decade has shown a tremendous growth in the creation and application of Volunteered Geographic Information (VGI), collected by volunteers and free to use. Like other national mapping agencies, Kadaster already gained experience with crowdsourcing in processing user reports submitted through the BRT user feedback system, and recently, a new maintenance process was setup to check and supplement toponymic BRT data in cooperation with local historical societies.

To investigate the potential of crowdsourcing as a solution to the maintenance problem of toponymic data, and as an addition to the procedures started up with local historical societies, a pilot VGI application has been built to collect the boundaries and names for area features in the BRT. Volunteers were asked to draw polygons with the approximate boundaries of geographical areas and provide the area type, the name of the area as well as their e-mail address. Thanks in part to an adequate communication, the test of the *Vlakbijnamen* application during a 1.5-month pilot period was a great success in terms of participation and received unanimously positive response.

An analysis of the resulting data learns that the vast majority of the features seems flawless and usable, although some are missing attribute information. To avoid the registration of incorrect boundaries and erroneous or misspelled names, a dedicated team of employees with sufficient knowledge and insight in the rules and regulations of toponymic data is needed to assess the quality and implement adjustments, or to decide not to implement the contribution in the BRT. If available, cooperating local historical societies can be called in to do a last verification check.

If a thorough quality assessment is guaranteed and consistent rules and regulations are provided, it is recommended to implement this method of data collection with a VGI application in the maintenance process of the BRT. Experiences from the user feedback system seem promising for the feasibility to maintain other names categories with the help of crowdsourcing as well, although the possibility to indicate the fuzzy character of area boundaries in the BRT is still to be realized. Not less important is it to finally achieve the national standardization of geographical names in the Netherlands, in order to facilitate their consistent and correct use in government and society.

Samenvatting

Al meer dan 200 jaar vormen aardrijkskundige namen een prominent en onmisbaar onderdeel van de nationale topografische kaartproductie in Nederland. Echter, kort nadat de Topografische Dienst opging in het Kadaster en de topografische kaarten en bestanden een wettelijke status kregen als Basisregistratie Topografie (BRT), werd in 2009 gestopt met de tijdrovende terreinverkenning, die de belangrijkste bron vormde voor de naamgegevens. Daardoor konden grote delen van deze gegevens niet meer bijgehouden worden, ondanks de wettelijke verplichting daartoe. Aardrijkskundige namen zijn immers niet zichtbaar op luchtfoto's en de meeste namen ontbreken ook op straatbeeldfoto's, of zijn daarop niet leesbaar.

Op basis van het principe 'eenmalige inwinning, meervoudig gebruik', maakt het Kadaster in toenemende mate gebruik van externe data als bron voor de gegevens in de BRT. Sommige van deze bronnen bevatten naamgegevens en zijn geschikt als bron voor het bijhouden van een aantal naamcategorieën in de BRT. Het betreft vooral overheidsdata, zoals straatnamen en woonplaatsnamen in de Basisregistratie Adressen en Gebouwen (BAG) of de 'buitengaatse' waternamen op de zeekaarten van de Dienst der Hydrografie. Voor andere naamcategorieën zijn echter geen bronnen beschikbaar die voldoen aan de actualiteits- en kwaliteitseisen die gelden voor basisregistraties als de BRT. Het gaat dan bijvoorbeeld om gebouwnamen en gebiedsnamen.

In de laatste tien jaar is er een enorme toename zichtbaar in het aanbod en de toepassing van vrijwillige geo-informatie (VGI); data, verzameld door vrijwilligers, die vrij te gebruiken is. Net als topografische diensten in andere landen, heeft het Kadaster al ervaring opgedaan met *crowdsourcing* door het verwerken van terugmeldingen van gebruikers, die binnenkomen via het BRT terugmeldsysteem, en recent nog door het opzetten van een nieuw bijhoudingsproces voor het controleren en aanvullen van naamgegevens in de BRT, in samenwerking met lokale historische verenigingen.

Om de mogelijkheden van *crowdsourcing* te onderzoeken, als oplossing voor het probleem met het bijhouden van de naamgegevens en als aanvulling op de informatie van de historische verenigingen, is een VGI-testapplicatie gebouwd voor het verzamelen van de begrenzingen en namen van gebiedsobjecten in de BRT. Vrijwilligers is gevraagd vlakken voor geografische gebieden in te tekenen, daarvoor bij benadering de grenzen te bepalen, en het type gebied, de naam van het gebied en hun e-mailadres op te geven. Mede door een goede communicatiestrategie is het testen van de Vlakbijnamen-applicatie in de 1,5 maand durende proefperiode een groot succes geworden: de deelname was groot en de reacties onverdeeld positief.

Een analyse van de uitkomsten leert dat het overgrote deel van de objecten foutloos en bruikbaar lijkt, ook al is de attribuutinformatie bij een deel van de objecten onvolledig. Om te voorkomen dat onjuiste gebiedsgrenzen, verkeerde namen, of namen met spelfouten in de BRT terechtkomen, is voor de verwerking een team van ervaren medewerkers nodig, met voldoende kennis en inzicht in de regels en richtlijnen voor naamgegevens. Zij moeten de kwaliteit van de bijdrages beoordelen, de nodige aanpassingen doen om deze geschikt te maken, of besluiten om deze niet te verwerken. Indien mogelijk en beschikbaar kan de lokale historische vereniging helpen door nog een laatste controle uit te voeren.

Als een grondige kwaliteitscontrole verzekerd is en er zijn eenduidige regels en richtlijnen beschikbaar voor het registreren van de namen, verdient het aanbeveling de VGI-applicatie voor het verzamelen van naamgegevens in te voeren in het bijhoudingsproces van de BRT. Ervaringen met het BRT-terugmeldsysteem zijn veelbelovend voor de mogelijkheden om ook andere naamcategorieën door middel van *crowdsourcing* bij te houden. Wel is het nog zaak om de mogelijkheid te creëren het onzekere karakter van gebiedsbegrenzingen in de BRT aan te kunnen geven. Zeker niet minder belangrijk is het om eindelijk de aardrijkskundige namen in Nederland te standaardiseren, en daarmee een eenduidig en correct gebruik van namen te faciliteren, zowel binnen de overheid als in de samenleving.

List of abbreviations

Abbreviation	Explanation in English	Explanation in Dutch or local language
AHN	Current Height File of the Netherlands	Actueel Hoogtebestand Nederland
AIV	Flemish Agency for Information	Agentschap Informatie Vlaanderen
ANWB	Royal Dutch Touring Club	Koninklijke Nederlandse Toeristenbond
APV	General Local Ordinance	Algemene Plaatselijke Verordening
BAG	Key Register of Addresses and Buildings	Basisregistratie Adressen en Gebouwen
BGT	Key Register of Large-scale Topography	Basisregistratie Grootschalige Topografie
BKG	Federal Office for Cartography and Geodesy	Bundesamt für Kartographie und Geodäsie
BRP	Key Register of Persons	Basisregistratie Personen
BRT	Key Register of Topography	Basisregistratie Topografie
CBS	Central Bureau of Statistics	Centraal Bureau voor de Statistiek
CEMT	European Conference of Ministers of Transport	Europese Conferentie van Ministers van Verkeer
COST	European Cooperation in Science and Technology	Europese samenwerking inzake wetenschap en technologie
CRAB	Central Reference Addresses Database	Centraal Referentieadressenbestand
EU	European Union	Europese Unie
GBKN	Large-scale Base Map of the Netherlands	Grootschalige Basiskaart Nederland
GIMA	Geographical Information Management and Applications	Geographical Information Management and Applications
GIS	Geographic Information System	Geografisch informatiesysteem
GPS	Global Positioning System	Wereldwijd plaatsbepalingssysteem
GRB	Large-scale Reference Database	Grootschalig Referentiebestand
ICT	Information and Communication Technology	Informatie- en communicatietechnologie
ID	Identification (Code)	Identificatie(code)
IGN España	National Geographic Institute of Spain	Instituto Geográfico Nacional
IGN France	National Institute of Geographic and Forest Information	Institut national de l'information géographique et forestière
IMGeo	Information Model Geography	Informatiemodel Geografie
ISBN	International Standard Book Number	Internationaal Standaard Boeknummer
ISO	International Organization for Standardization	Internationale Organisatie voor Standaardisatie
KNAG	Royal Netherlands Geographical Society	Koninklijk Nederlands Aardrijkskundig Genootschap
MCA	Maritime and Coastguard Agency	Maritime and Coastguard Agency
MoSCoW	Must have, Should have, Could have, Won't have	Must have, Should have, Could have, Won't have
MV	Military Reconnaissance Agency	Dienst der Militaire Verkenningen
NGI	National Geographic Institute of Belgium	Nationaal Geografisch Instituut
NLS	National Land Survey of Finland	Maanmittauslaitos
NMA	National Mapping Agency	Nationale topografische dienst

NSW	Natural Scenery Act	Natuurschoonwet
NWB	National Roads Database	Nationaal Wegenbestand
OS	Ordnance Survey	Ordnance Survey
OSM	OpenStreetMap	OpenStreetMap
PC	Personal Computer	Personal computer
PDOK	Public Service on the Map	Publieke Dienstverlening op de Kaart
RCTD	Royal Commission for Toponymy and Dialectology	Koninklijke Commissie voor Toponymie en Dialectologie
RVO	Netherlands Enterprise Agency	Rijksdienst voor Ondernemend Nederland
SDFE	Agency for Data Supply and Efficiency	Styrelsen for Dataforsyning og Effektivisering
TD	Topographic Survey	Topografische Dienst
TI	Topographic Institute	Topographische Inrichting
UN	United Nations	Verenigde Naties
UNGEGN	United Nations Group of Experts on Geographical Names	Expertgroep van de Verenigde Naties voor Aardrijkskundige Namen
URL	Uniform Resource Locator	Uniforme bronlocator
VGI	Volunteered Geographic Information	Vrijwillige geo-informatie
VNG	Association of Dutch Municipalities	Vereniging van Nederlandse Gemeenten
WIS	Water Management Information System	Waterstaatkundig Informatie Systeem

Preface

It is not for everyone to turn a hobby into a career, but it certainly is for me. Ever since I was a small child, I was fascinated by atlases and maps, and my parents had to discard their school atlases and with youthful diligence collected King atlas to prevent me from ruining them by supplementing, with pen, the oh-so-necessary updates and corrections. It was therefore obvious to choose a study in line with my interests, human geography, and I also succeeded in finding a job that fits in with that, in the national mapping agency of the Netherlands. Thanks to my employer, I could follow and now finally finish the GIMA master program.

It will not surprise that the topic of this thesis is relevant to my work. Toponymy always had my special attention and I soon became specialized in it at my work, if only because nobody else was interested. With the rise of crowdsourcing in the previous years, I already proposed the present thesis subject for an assignment in GIMA module 1. The combination of a work related and very familiar subject undoubtedly facilitated the execution of the research and the writing about it.

Nevertheless, a lot of time has passed between the start of the research and the result that is now in front of you. The explanation can partly be sought in private circumstances, but busy work also demanded a lot of attention. This is why the preparation, the first part of literature research as well as the intensive process of building and testing the VGI application took place in 2014 and the first three months of 2015, while the thesis itself has only been written in the past four months. The interruption of 3 years did offer the opportunity to include recent developments in data collection and crowdsourcing in the research, thereby further increasing its relevance.

Without the help and support of a large number of people, the research and this thesis could still not have been completed. I want to acknowledge and thank all of them here. In the first place Grads, the manager of my department, who gave me the opportunity to follow this master program. Magdalena, through her connections, helped me with the registration for GIMA well after the deadline, and was a big support in building the VGI application with her knowledge and experience of ArcGIS Online. The Communication department of Kadaster helped with advertising the pilot on its website and on social media, which has proved to be the key to success. Of course, I am grateful to all volunteers who used the application and made one or more contributions during the pilot; some even very many. Those who shared their user experiences additionally made a very valuable contribution.

Many thanks go to Rob and Ferjan, my supervisors, for their willingness to guide me in this research, for sharing their knowledge on crowdsourcing and geographical names, their helpful remarks, and their patience and encouragement to finish this thesis. Finally, I want to thank my family and friends for all their support, love and understanding.

I am very happy that the thesis has now been completed, but I did the research and writing with a lot of pleasure. Hopefully this can be read from the text, inspires while reading and stimulates interest in the subject. Because geographical names certainly deserve and can use some extra attention.

Zwolle, 19 July 2018

Table of contents

1. Introduction

1.1 Motivation and problem statement

In 2008, the national topographic databases of the Netherlands became part of a system of key registers as the *Basisregistratie Topografie* (BRT, Key Register of Topography). This key register system was set up by Dutch government to ease data exchange, improve and guarantee data quality and to promote the principle 'collect once, use many times' (Kadaster 2017).

To realize this, Kadaster, the national mapping agency of the Netherlands and responsible for maintenance of the BRT, wants to use existing data from third parties as a source for the BRT. Currently, only data sets from other governmental bodies have been examined for this purpose. However, in the past decade a lot of free to use Volunteered Geographic Information (VGI) became available, such as OpenStreetMap (Goodchild 2011).

The rise of VGI is linked to a wider development of enabling private individuals, as a network of people, to perform activities that once were the restricted domain of (governmental) institutions or companies – a development that has come to be known as crowdsourcing (Howe 2006). In the context of this research, crowdsourcing can be defined as the activities aimed at collecting data with the help of the people, while VGI in the geographic information sector is the product of these activities, insofar as they have been carried out by volunteers.

Kadaster wants to explore the possibilities to use crowdsourcing in its production and maintenance processes. The experiences with the current easy-to-use BRT user feedback system (*terugmeldvoorziening*) suggest a large potential for user contributions to the BRT.

For years, parts of the BRT data are not or hardly updated due to the fact that it was decided to stop the intensive field work necessary for its maintenance. The data concerned are mainly those related to toponyms. Last year, a new process was started aiming at cooperation with local historical societies for checking and complementing toponymic data. This has led to great enthusiasm amongst the societies and some very promising results, but not in all parts of the Netherlands historical societies do cooperate and especially the demarcation of boundaries for area features is hardly provided by them.

Assuming that crowdsourcing is a useful if not inevitable solution to this problem, the question is what methods, rules and regulations should be defined for the registration of toponymic data, in order to secure the consistency and quality required for authentic key register data.

The idea of giving the 'crowd' the opportunity to directly contribute to the BRT has been investigated by setting up a VGI application for toponymic data that cannot be maintained by use of other sources. The research primarily focuses on the rules and regulations needed to unambiguously define the geometry of areas and the orthography of geographical names. In a wider context, other aspects concerning toponymic data and the introduction of crowdsourcing in the BRT's production process, such as the usage of existing external data sources, the experiences in other countries, and the practical and organizational implementation of VGI data, are identified as well.

1.2 Research objectives

The main objective of the research is to define methods, rules and regulations for the registration of toponymic VGI data in the BRT. This has been done in the context of finding an alternative method for the necessary updating of (toponymic) BRT data that is not addressed in the current revision process. At the same time, by testing the use and usefulness of VGI for the maintenance process of the BRT the question is answered whether it is possible and advisable to use crowdsourcing data in the Dutch national topographic databases. The research may help Kadaster as maintainer of the BRT to further improve the production process, and it contributes to the general discussion on the relevance and usability of crowdsourcing data in the public domain.

1.3 Research questions

The research questions are derived from 3 main questions. Below the main and sub questions are listed, with reference to the sections of the thesis in which they are mainly addressed.

1. What are the requirements for toponymic data?
   - 1.1 What toponymic data are present in the BRT? → § 2.2
   - 1.2 How were these data collected and maintained in the past? → § 2.1
   - 1.3 What are the legal, functional or other requirements for BRT data? → § 2.4
   - 1.4 What are the legal, functional or other requirements for toponymic data? → § 2.5
   - 1.5 How can these be expressed as rules and regulations for a data collection system? → § 2.6
   - 1.6 What other data sources containing toponyms are available? → § 3.1
   - 1.7 What methods of crowdsourcing exist? → § 3.2
   - 1.8 Which of these methods would answer the requirements of BRT and toponymic data? → § 3.3
   - 1.9 How are toponymic data handled by other national mapping agencies? → § 3.4
   - 1.10 What are the experiences in the use of crowdsourced toponymic data by national mapping agencies? → § 3.5
   - 1.11 How would the use of VGI affect the workflow of processing toponymic data at Kadaster? → § 3.7
   - 1.12 According to what criteria can toponymic VGI data be evaluated? → § 3.8

2. How to build a VGI application to collect toponymic data that fulfils all requirements?
   - 2.1 What are the requirements for a VGI application? → § 4.1
   - 2.2 How to set up a VGI application? → § 4.2

3. How to evaluate VGI for toponymic data?
   - 3.1 What is the quality of the data collected with the VGI application? → § 5.2
   - 3.2 How can these data be processed at Kadaster? → § 5.3
   - 3.3 What conclusions can be drawn and recommendations can be distilled from the research? → § 6.4
   - 3.4 What changes or additions to the methods, rules and regulations are needed, based on the research, for Kadaster to implement it? → § 6.5

1.4 Scope

Although there is a research question regarding the influence of VGI on the workflow, the full practical and organizational implementation of VGI in the maintenance process of the BRT will not be investigated in the research. Therefore, questions regarding the feasibility of the implementation are out of scope and will not be addressed.

Regarding the registration of toponymic data in the BRT, only the registration in the topographic database - mainly TOP10NL - is investigated. Issues regarding the visualization or cartographic representation of features and names are not within the scope of this research.

As the BRT currently only contains data for the European part of the Netherlands, the collection and registration of geographical names in the Caribbean Netherlands for this research have been left out of consideration. The history, languages and culture of the islands of Bonaire, Sint Eustatius and Saba, which since 2010 together make up the Caribbean Netherlands, are so different, that also the methods, rules and regulations will most likely differ from those in the European part of the Netherlands. It is expected however, that the topographic data of the three islands will soon be included in the BRT, which means that also the corresponding toponymic data have to be collected, registered and maintained, according to the requirements for toponymic and BRT data as described in this thesis. It is therefore important for Kadaster to consider which approach would best meet the demands, and the results of this research might be helpful in that decision-making process.

The islands of Aruba, Curaçao and Sint Maarten are each an autonomous country within the Kingdom of the Netherlands, and have their own governmental institutions. Although Kadaster does make topographic maps of the islands for the Ministry of Defense, the countries themselves are responsible for their mapping. They are not within the scope of the BRT and this research.

1.5 Relevance

Until recently, no tradition in the use of data originating from other than official sources existed in the maintenance process of the BRT. This may not surprise, as most of modern crowdsourcing data became available only with the development of various relevant platforms on the internet in the past 10 to 15 years. This may be seen in a broader context of democratization of knowledge and information through modern means of communication. The research responds to these developments as it investigates the methods, rules and regulations needed for the integration of these new sources of information in the traditional production and maintenance processes of official topographic databases and maps.

1.6 Method

The research has been carried out by subsequently performing literature study, extracting rules and regulations for toponymic data, designing and testing a VGI application and evaluating the test results.

The research starts with a first phase of literature study to gain more knowledge of the requirements of BRT and toponymic data. Based on this, rules and regulations for registration of toponymic data can be determined. Literature study on the existing data sources containing toponyms has been done in order to determine what toponymic data are not available in these sources or cannot be maintained by using them. Methods of crowdsourcing and experiences with crowdsourcing and toponymic data in a selected number of other countries have been identified and studied to find the best method to collect toponymic VGI data. Also, the criteria for evaluation of the data have been set.

In a second phase, a VGI application has been built and made operational as a proof of concept, by implementing the application requirements set before. The compiled rules and regulations have been taken into account as well. Established data structures and experiences from other applications have

been translated to a set of tools to be used by volunteers to submit their contributions. After finishing the building of the application, the crowd has been invited to use it during a pilot period of 1.5 month.

After the pilot period, in a third and last phase the resulting data have been analyzed and, based on this analysis, conclusions have been drawn on the usability of the crowdsourcing method and the need for change or addition of the rules and regulations for toponymic data. Recommendations have been given for the implementation of a final application.

1.7 Reading guide

Chapter 2 starts with a description of the historic context of toponymic data in the Netherlands and the way they were handled by governmental agencies, as well as how geographical names are currently registered in the BRT, with a case study of the built-up areas in TOP10NL as an extensive example. The chapter continues with a discussion of the legal, functional and other requirements for BRT data in general and toponymic data in particular, with the standardization rules and efforts as an important aspect.

An overview of all existing data sources containing toponyms is given in Chapter 3, in order to identify for which names categories sources are available and useful and for which crowdsourcing might be a suitable source. This is followed by a discussion of the various methods for crowdsourcing and an identification of the methods suitable for collecting toponymic data. Section 3.4 provides the methods a selected number of other national mapping agencies in Europe use to collect and maintain toponymic data, and in Section 3.5 the experiences they have gained with crowdsourcing toponymic data are described. As a second case study, the recently started process to check and complement toponymic data in the BRT in cooperation with local historical societies is explained. In Section 3.7, the consequences of introducing a VGI application for the maintenance process of the BRT are discussed and in Section 3.8 the evaluation criteria for the resulting data from this application have been listed.

Chapter 4 describes the process of setting up requirements for a VGI application, building an application and preparing a pilot to test the application with volunteers. In Chapter 5 the results of the pilot are analyzed using the evaluation criteria listed in Section 3.8. Finally, Chapter 6 provides the answers to the research questions as well as general conclusions and recommendations from this research.

An explanation of the most important terms used can be found in the glossary at the end of this thesis.

2. Rules and regulations on toponymic data registration

2.1 History of toponymic data in Dutch national mapping

The history of national governmental mapping of the Netherlands started in 1798. Three years before, inspired by the French Revolution and with support from revolutionary forces in France, the confederated Republic of the United Netherlands was replaced by the Batavian Republic. In the next years, supporters for a federalist structure were gradually overruled by the more radical centralist fraction, which succeeded in 1798 in the popular approval of a centralist constitution.

With a new departmental division modeled on France, it became important to map the country on a national scale. Before, the largely autonomous provinces were each responsible for mapping and their maps did not match together. Therefore, scientist and military adviser Dr. C.R.T. Krayenhoff was appointed with the task of producing a national map, based on a new triangulation of the country. The surveying and engraving for this purpose was done between 1798 and 1822 and the map was printed from 1809 (Kadaster 2018f). Due to the – to current standards – relatively small scale of 1:115,200, corresponding to 800 Rhenish rods to an inch, toponyms included predominantly place and water names (Figure 1). For the place names, the newly established municipalities were asked by questionnaire to provide the correct spelling of their name (Ormeling 2003). Most names were put in the Siegenbeek spelling, which came into force in 1804 and was the first unified Dutch spelling.

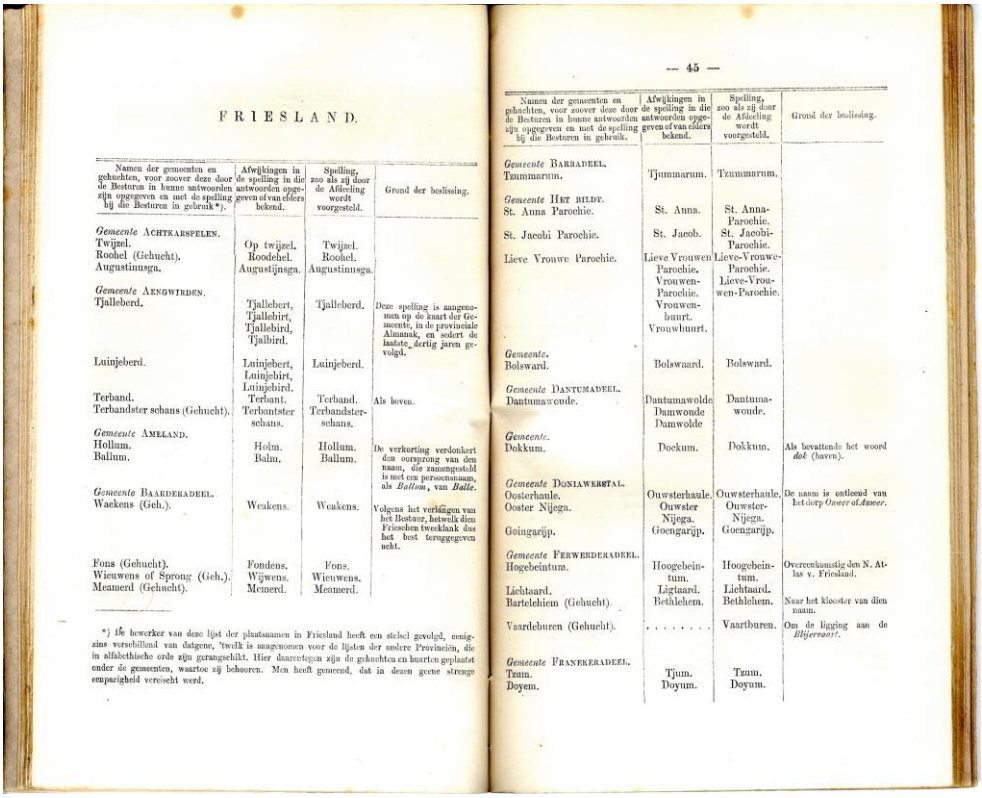
Figure 1. Detail of a Krayenhoff map north of Zwolle.

In 1806, under the then new dispensation of the Kingdom of Holland, a military agency for mapping was established: the Topographic Bureau (*Topographisch Bureau*), part of the General War Depot (*Depot-Generaal van Oorlog*). In 1810 all Dutch military agencies ceased to exist due to the French annexation of the kingdom, but after the Napoleonic Wars finally resulted in a victory of the Coalition against France, in 1813-1815 the Netherlands were re-established as an independent kingdom, now

officially called the Kingdom of the Netherlands. The Topographic Bureau was reconstituted, together with the Military Reconnaissance Agency (*Dienst der Militaire Verkenningen*, MV) for the surveying tasks (Kadaster 2014).

From then on, national mapping was based on cadastral maps, which are combined using the triangulation network and enriched and colored based on the field surveys by officers-surveyors on horseback. Maps were then printed on a lithographic press. Only after 1932 aerial images became available, making the time-consuming and inefficient combination of cadastral maps superfluous. Meanwhile the name of the Topographic Bureau changed to Topographic Institute (*Topographische Inrichting*, 1868), and in 1932 for efficiency reasons the TI and the MV merged into the Topographic Survey (*Topografische Dienst*, TD).

Toponymic data for the detailed topographic maps were collected predominantly during the field surveys. Field names and building names were gathered by interviewing the local population. To advise on the spelling of place names, at the request of the Ministry of War in 1857 the Royal Academy of Arts and Sciences installed a scientific commission with the task to provide a standardized spelling of place names. As was done for the Krayenhoff map, the commission sent questionnaires to the municipalities to gather the names in use by its administration, but it also proposed a standardized spelling form. In 1864 this resulted in the publication of the Dutch Place Names List (*Lijst van Nederlandsche Plaatsnamen*), with for each municipality a list of place names provided by the local administration, known alternative spellings and the spelling proposed by the commission (Figure 2). However, the use of the List was not imposed by the ministry of the Interior (Ormeling 2009).



FRIESLAND.

Namen der gemeenten en gehuchten, voor zoover deze door de Besturen in hunne antwoorden opgezijn opgegeven en met de spelling bij die Besturen in gebruik*).	Afwijkingen in de spelling in die antwoorden opgegeven of van elders bekend.	Spelling, zoo als zij door de Afdeeling wordt voorgesteld.	Grond der beslissing.
Gemeente ACHTKARSPELEN.			
Twijzel.			
Roohel (Gehucht).	Op twijzel. Roodehel.	Twijzel. Roohel.	
Augustinusga.	Augustijnsga.	Augustinusga.	
Gemeente AENGWIRDEN.			
Tjalleberd.	Tjallebert, Tjallebirt, Tjallebird, Tjalbird.	Tjalleberd.	Deze spelling is aangenomen op de kaart der Gemeente, in de provinciale Almanak, en sedert de laatste dertig jaren gevolgd.
Luinjeberd.	Luinjebert, Luinjebirt, Luinjebird.	Luinjeberd.	
Terband.	Terbant.	Terband.	Als boven.
Terbandster schans (Gehucht).	Terbantster schans.	Terbandster-schans.	
Gemeente AMELAND.			
Hollum.	Holm.	Hollum.	De verkorting verdonkert den oorsprong van den naam, die zamengesteld is met een persoonsnaam, als *Bollum*, van *Balle*.
Ballum.	Balm.	Ballum.	
Gemeente BAARDERADEEL.			
Waekens (Geh.).	Weakens.	Weakens.	Volgens het verslagen van het Bestuur, hetwelk dien Friesschen tweeklank dus het best teruggegeven acht.
Fons (Gehucht).	Fondens.	Fons.	
Wieuwens of Sprong (Geh.).	Wijwens.	Wieuwens.	
Meamerd (Gehucht).	Meinerd.	Meamerd.	

*) De bewerker van deze lijst der plaatsnamen in Friesland heeft een stelsel gevolgd, eenigzins verschillend van datgene, twelk is aangenomen voor de lijsten der andere Provinciën, die in alfabethische orde zijn gerangschikt. Hier daarentegen zijn de gehuchten en buurten geplaatst onder de gemeenten, waartoe zij behooren. Men heeft gemeend, dat in dezen geene strenge emparigheid vereischt werd.

— 45 —

Namen der gemeenten en gehuchten, voor zoover deze door de Besturen in hunne antwoorden opgezijn opgegeven en met de spelling bij die Besturen in gebruik.	Afwijkingen in de spelling in die antwoorden opgegeven of van elders bekend.	Spelling, zoo als zij door de Afdeeling wordt voorgesteld.	Grond der beslissing.
Gemeente BARHADEEL.			
Tzummarum.	Tjummarum.	Tzummarum.	
Gemeente HET BILDT.			
St. Anna Parochie.	St. Anna.	St. Anna-Parochie.	
St. Jacobi Parochie.	St. Jacob.	St. Jacobi-Parochie.	
Lieve Vrouwe Parochie.	Lieve Vrouwen Parochie. Vrouwen-Parochie. Vrouwen-buurt. Vronwbuurt.	Lieve-Vrouwe-Parochie. Lieve-Vrouwen-Parochie.	
Gemeente.			
Bolsward.	Bolswaard.	Bolsward.	
Gemeente DANTUMADEEL.			
Dantumawoude.	Dantumawolde Damwonde Damwolde	Dantuma-woude.	
Gemeente.			
Dokkum.	Dockum.	Dokkum.	Als bevattende het woord *dok* (haven).
Gemeente DONIAWERSTAL.			
Oosterhaule.	Ouwsterhaule.	Ouwsterhaule.	De naam is ontleend van het dorp *Ouwer of Ouwer.*
Ooster Nijega.	Ouwster Nijega.	Ouwster-Nijega.	
Goingarijp.	Goengarijp.	Goengarijp.	
Gemeente FERWERDERADEEL.			
Hogebeintum.	Hoogebein-tum.	Hoogebein-tum.	Overeenkomstig den N. Atlas v. Friesland.
Lichtaard.	Ligtaard.	Lichtaard.	
Bartelehiem (Gehucht).	Bethlehem.	Bethlehem.	Naar het klooster van dien naam.
Vaardeburen (Gehucht).	. . . . .	Vaartburen.	Om de ligging aan de *Blijerwaart.*
Gemeente FRANEKERADEEL.			
Tzum.	Tjum.	Tzum.	
Doyem.	Doyum.	Doyum.	

Figure 2. Detail of the Dutch Place Names List published in 1864.

This resulted in the continued use of different spellings in the various administrations. The Topographic Institute and later the Topographic Survey made its own rules for capturing the spelling of geographical names, which appear to differ from the choices made by other national governmental agencies, such as Rijkswaterstaat (Agency for Public Works and Waterways), the post and telegraph authority, the statistics agency and the railway companies that later formed the Dutch Railways (Ormeling 2003).

In 1884, as a reaction to discussions in parliament on the usefulness of the rather unstandardized place name spelling in existing acts and laws as a new standard, the Royal Netherlands Geographical Society (*Koninklijk Nederlandsch Aardrijkskundig Genootschap*, KNAG) published a Gazetteer of Geographical Names in the Netherlands (*Woordenlijst voor de spelling der aardrijkskundige namen in Nederland*), containing 13,000 place names spelled in accordance with the new De Vries and Te Winkel spelling prepared by Dr. M. de Vries and Dr. L.A. te Winkel, which became effective the year before. Although new editions were published regularly in the next decades, with an even larger List of Geographical Names of the Netherlands (*Lijst der aardrijkskundige namen in Nederland*) published in 1936, these gazetteers did not get any authorization by the government.

In the 1947 spelling act the new Marchant spelling was introduced, based on some of the simplifications to the De Vries and Te Winkel spelling proposed by linguist Dr. R.A. Kollewijn in 1891. In the act an explicit exception in the obligatory application of the Dutch spelling rules is made for geographical names in the Netherlands, although street names did have to be adapted.

The modernization of geographical names appeared to be a sensitive matter, and proposals made by the Dutch government to apply the new rules to municipality names in the province of North Brabant led to massive protests (Ormeling 2009). Finally, in 1962 the Dutch government installed a linguistic commission to prepare a unified spelling for geographical names.

After 11 years of debate the Dutch-Belgian Word List Commission on Geographical Names within the Netherlands (*Nederlands-Belgische woordenlijstcommissie aardrijkskundige namen binnen Nederland*) chaired by Dr. B.C. Damsteegt presented its final report in 1973. Attached to the report, an example names list in accordance with the proposed orthography rules is provided for letters A and M (Figure 3), while in the archives of the commission at the Meertens Institute draft names lists can be found of all geographical names present on the topographic maps of that time, except place names (Meertens Instituut 2018a).

Afdeling Vijfhuizen geb tussen Hoofddorp,
Cruquius, Halfweg en Lijnden nh
Afferden (Druten gld) 51.53 n - 5.38 o
Afferden (Bergen l) 51.38 n - 6.01 o
Afferdense- en Deestsewaarden geb n Afferden
gld
Afgedamde Maas wat van Wel gld naar Woudrichem
nb
Afgelatenven geb zw Achtmaal nb
Afgeslotenij wat in Amsterdam nh
Afhang geb w Horst l
Afleidingskanaal wat ono Zutfen gld
Afleidingskanaal wat o langs Bokstel nb
Afleidingskanaal wat van 3 km no Rips
naar 2 km o Vierlingsbeek nb
Afsluitdijk dijk w Wel gld
Afsluitdijk dijk o Giesen nb
Afsluitdijk dijk van Den Oever nh
naar Zurich f
Afsched (Genemuiden o) 52.36 n - 6.01 o
Afvoerkanaal wat w Kralingseveer zh
Afvoersloot van het Vlijmensven
wat zw Vlijmen nb
Afwateringskanaal wat van 2 km zzo Meiel
naar 2 km ono Neer l
Afwateringskanaal wat wzw Genemuiden o
Afwateringskanaal van Duurswold wat van
3 km no Harkstede door het Schildmeer
naar Delfzijl gr
Afwateringskanaal van 's Hertogenbos naar
Drongelen wat van 's Hertogenbos naar
1 km o Drongelen nb
Afwateringskanaal van Koevorden naar de
Vecht wat van Koevorden d naar 1 km
w Gramsbergen o
Agelerbroek geb zo Ootmarsum o
Agelerveld geb z Ootmarsum o
Aggerkapitale Uitwatering wat zzw
Woensdrecht nb
Aggeruitwatering wat w Ossendrecht nb
Agnietenberg hgt nw Berkum Bruggenhoek o
Agodorp (Vlachtwedde gr) 52.52 n - 7.05 o
Akerdijk dijk van Lijnden naar
Badhoevedorp nh
Akersn geb wnw Hedel gld
Akersloot nh
Akersloot (Akersloot nh) 52.34 n - 4.44 o
Akkepollegat wat Zeegat van Ameland
Akker , Den (Echteld gld) 51.54 n - 5.28 o
Akker (Wouw nb) 51.31 n - 4.23 o
Akker (Driebergen-Rijzenburg u) 52.03 n - 5.17 o
Akkerdijkseplassen plassen zw Oudelede zh
Akkerdijksepolder geb zw Oudelede zh
Akkereind(Veldhoven nb) 51.25 n - 5.26 o
Akkereinden geb nw Siddeburen gr
Akkereven geb wzw Huibergen nb
Akkerlingen geb wzw Hoeven, Hoeven nb
Akkerman, Polder, geb zw Oranjewoud f
Akkerman, Polder geb w Terhorne f
Akkermansbeek wat van 1 km wnw
Westendorp naar Terborg gld
Akkerwaten geb ozo Wachtum d
Akkerput (Oostburg z) 51.21 n -3.28 o

Akkers geb n Echten f
Akkers geb w Hedel gld
Akkers geb o Drimmelen nb
Akkers geb n Kloosterhaar o
Akkersloot wat zo Oudade zh
Akkerwoude (Dantumadeel f) 53.18 n - 5.59 o
Akkerwoudsterbroek (Dantumadeel f) 53.17 n - 6.00 o
Akkerwoudstervaart wat van Akkerwoude f richting nnw
Akkooi (Beesd gld) 51.53 n - 5.08 o
Akkooiseheuvel hgt 4 km n Akkooi gld
Akkooiseweer wat n Akkooi gld
Akkrum (Utingeradeel f) 53.03 n - 5.50 o
Akkrumerrak wat zzw Akkrum f
Akmarijp (Utingeradeel f) 53.00 n - 5.47 o
Akmarijpsterpolder geb no Akmarijp f
Aksel z
Aksel (Aksel z) 51.16 n - 3.54 o
Akselsekreek wat wzw Aksel z
Akselsesassing (Aksel z) 51.16 n - 3.52 o
Akselsevlakte geb zzo Sluiskil z
Akswijk (Zeevang nh) 52.32 n - 5.01 o
Alanden geb nno Zwolle o
Alberdinawijk wat nno Nieuwamsterdam d
Albergen (Tubbergen o) 52.22 n - 6.46 o
Albergerveld geb n Zenderen o
Albernest geb nw Ansen d
Alberta geb zw Hogersmilde d
Albert Louwesloot wat van Watergang nh richting o
Alblas wat van Laagblokland naar Alblasserdam zh
Alblashaven wat zzo Overschie zh
Alblaspolder geb ozo Lagezwaluwe nb
Alblasserdam zh
Alblasserdam (Alblasserdam zh) 51.52 n - 4.40 o
Alblasserwaard landstreek in Zuidholland,
tussen de Lek, het Merwedekanaal, de
Merwede en de Noord
Albrandswaard, Polder geb ozo Poortugaal zh
Albrandswaardsedijk dijk van Poortugaal zh
richting zo
Aldlân zie Oudland
Alem (Maasdriel gld) 51.47 n - 5.21 o
Alemsebroek geb ono Gewande nb
Alemse en Drielse Uiterwaard geb zzo Alem gld
Alemse Overwaard geb nw Alem gld
Alendorp (Vleuten-De Meern u) 52.06 n - 5.02 o
Alendorperwetering wat n De Meern u
Alfen (Appeltern gld) 51.49 n - 5.28 o
Alfen (Alfen en Riel nb) 51.29 n - 4.57 o
Alfen aan de Rijn zh
Alfen aan de Rijn (Alfen aan de Rijn zh) 52.08 n - 4.40 o
Alfen Boshoven (Alfen en Riel nb) 51.28 n - 4.57 o
Alfen en Riel nb
Alfen Oosterwijk (Alfen en Riel nb) 51.30 n - 4.59 o
Alfen Oosterwijkse Akkers geb no Alfen
Alfen Oosterwijkseheide geb no Alfen nb
Alfensebergen geb w Alfen nb
Alfense Uitvliet wat van 2 km n Greffeling
naar 2 km o Herewaarden gld
Alfenseweterring wat zzw Alfen aan de Rijn zh
Alferbos geb o Beetsterzwaag f
Alferveld geb ozo Beetsterzwaag f
Alferwatering wat van Boskoop naar Waddingsveen zh
Alfrinkshoek geb zzo Wezepe o

Figure 3. Detail of the names list attached to the report of the Damsteegt commission, 1973.

However, until today no government has taken action in implementing the proposals into legislation (Ormeling 2003). Under the current Dutch Spelling Act of 2005, the exception for geographical names of the 1947 spelling act is no longer in force (wetten.overheid.nl 2018c). This implies the current spelling rules are also to be applied on all geographical names in the Netherlands.

One may wonder why all the standardization efforts of the past never became successful. The first gazetteer of 1864 was said to have lacked consistency and it appeared to be rather difficult to set up simple, easily applicable yet scientifically sound orthography rules for geographical names. Also the later gazetteers of the KNAG were regarded as of insufficient quality to become authoritative (Rentenaar 1990). By the time the Damsteegt commission did its work and presented its proposals, already a variety of counter arguments played a role. Some were focusing on the legal status of many provincial, municipal and place names as official names, combined with the fact that Dutch legislation has assigned provinces and municipalities with the authority to define these names autonomously, unlike the situation in many other countries. Others were focusing on the impact of large-scale name changes, requiring adjustments of many registers, databases and systems, correspondence and

promotional materials, name and road signs, etc. A key factor in all these arguments is the belief, grown after two centuries of habituation to unstandardized names, that these names are unchangeable and their spelling is just as much part of the heritage as the names themselves, even if it was customary in earlier times to adjust the spelling to the habits of its age (Rentenaar 1990).

During the 20th century, the civil importance of topographic maps became ever more important. The rise of tourism and recreation made topographic maps a valuable source of information for visitors to a region in order to find their way. In government, spatial planning procedures were set up to organize the rapid spatial development in the Netherlands in terms of housing, industries, infrastructure, land reclamation, etc. These planning processes provided a strong demand for detailed topographic information, which the Topographic Survey could provide.

Following the end of the Cold War, the importance of military products declined, making the Topographic Survey's role of providing maps to civil society even more prominent. Meanwhile, other branches of government were setting up different geo-information products, such as the Large-scale Base Map of the Netherlands. To integrate the production of national geographical information into one single governmental agency, it was decided to merge the Topographic Survey with the Cadastral Agency (*Dienst voor het kadaster en de openbare registers*, for short Kadaster), taking effect in 2004. The responsibility for national mapping thus shifted from the Ministry of Defense to the Ministry of Housing, Spatial Planning and Environment. Following a departmental reform in 2017, the responsibility for Kadaster in turn was transferred to the Ministry of the Interior and Kingdom Relations.

At times when maps were still drawn by hand, and a new edition took several years to prepare, the agency paid much attention to a careful data collection process for geographical names. As names are typically data that cannot be seen on aerial images, which are the main source of information for all topographic features on the map since the 1930s, they were collected during the standard field work visit of a topographer to the area of the map sheet.

With every edition all information was completely revised, meaning that with regard to the toponymy, all names on the previous map had to be verified with the corresponding sources. This could be as simple as reading a name plate on the front of a house or farm to verify the building name, but it also required a visit to the town hall of every municipality to check for the completeness and correctness of all place names and the current numbers of inhabitants. These numbers are used to decide upon the appropriate lettering size of names on the map. Area names, like region or field names, could originate from the municipality as well, or were collected by asking local inhabitants (Hogerwerf 2017). Using their knowledge and habits can in fact be regarded as some sort of crowdsourcing *avant la lettre*.

In addition, the Hydrographic Service (*Dienst der Hydrografie*) provided nautical maps with names of off-shore water features, while Rijkswaterstaat produced water management maps (*waterstaatskaarten*) that were used to collect polder and inland water names.

All these names and their sources were internally registered on a names model (Figure 4).

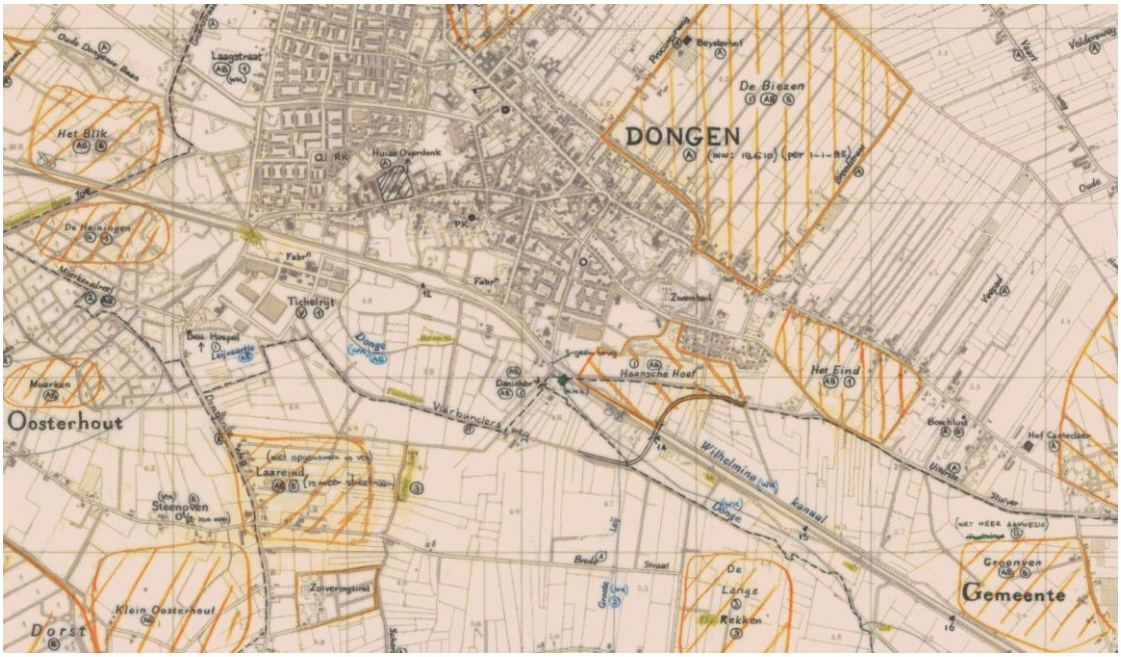


Figure 4. Detail of a names model of the Topographic Survey, 1985.

In the 1990s many changes in the production of topographic maps occurred. The production process was digitized, and the main output was changed from paper maps to a vectorized database. In the collection and processing of toponymic data, efficiency measures had the effect that during the field work toponyms were no longer verified in their totality, as only those changes were being processed that were mentioned by administrative sources.

In the 2000s, a new object-oriented database on a 1:10,000 scale was developed, TOP10NL, which eventually became the basis for the legislative fundament of the national mapping production in the new Key Register of Topography (*Basisregistratie Topografie*, BRT), coming into effect in 2008. The Kadaster Act prescribes the role of Kadaster as responsible for collecting the data and maintaining the database of the BRT (wetten.overheid.nl 2018b).

2.2 Toponymic data in the BRT

Data structure

According to the Kadaster Act, all topographic data in the BRT are classified into 10 categories:

- Road segment (*wegdeel*)
- Railway segment (*spoorbaandeel*)
- Water segment (*waterdeel*)
- Buildings (*bebouwing*)
- Terrain (*terrein*)
- Design element (*inrichtingselement*)
- Relief (*reliëf*)
- Administrative area (*registratief gebied*)
- Geographical area (*geografisch gebied*)
- Functional area (*functioneel gebied*)

BRT data should be accessible through an identifying feature number or a location on the map. The Act refers to the catalog of the BRT for more detailed characteristics of the data, including descriptive, geometric, cartographic, temporal and meta-characteristics. The catalog should also include the rules and procedures to edit the geographical features (wetten.overheid.nl 2018b).

In a data model the BRT data are structured according to a hierarchical order of feature classes, features, attributes and attribute values. The current catalog and product specifications for the BRT describes version 1.2 of the BRT data model, that became effective in September 2015. Contrary to the Kadaster Act, it distinguishes 13 data categories or feature classes (Kadaster 2017). In addition to the 10 classes mentioned in the Act, the model also contains classes for:

- Height (*hoogte*)
- Place (*plaats*)
- Planning topography (*plantopografie*)

In the model attributes and attribute values have been defined for each feature class. These attributes correspond to the characteristics of a feature (Kadaster 2017):

- identifying characteristics, being a unique ID code for each feature
- geometrical characteristics, being a point, line or polygon feature
- temporal characteristics, such as the start and end time of a feature
- meta characteristics, such as the source of a feature
- visualization characteristics, being the visualization code used in BRT raster products
- descriptive characteristics, including a wide variety of attribute information on specific feature classes.

Of all descriptive attributes, name attributes are the second most common attribute category next to feature type. Names are present in all feature classes except relief and height. In fact, most feature classes have 2 or more name attributes while 5 of them have separate attributes to indicate a Dutch name and a Frisian name. 3 feature classes even have an additional attribute to register the official name. The separate treatment of names in the Frisian language is a consequence of the recognition by the Dutch government of Frisian as an official minority language, both under European treaties and in national legislation. More information on this is provided in Section 2.4.

Although originally names could be provided for every feature class, the importance of the name attributes varies. For example, in case of relief the name attribute was hardly used, as the key characteristics of the feature are the geometry and the altitude. More or less the same is true for terrain features, where the type of terrain (grassland, cropland, forest, heathland, sand, etc.) determines their boundaries. Individual relief or terrain features usually had no separate name, but form part of a larger area bearing a geographical name, like dike, hill or field names. In the current version of the data model, the name attribute has disappeared for relief, but remained for terrain as it was deemed to be necessary to register names in specific situations, such as bridges that cannot be represented by a road, railway or water segment. Dike names are now part of the functional area feature class and can be registered with their geometric boundaries under the feature type *waterkering* (flood defense structure).

On the other hand, some feature classes have multiple name attributes. The road segment features can be attributed a street name, a bridge name and a tunnel name in case of such structures, as well as an exit name and a junction name in case of expressways and motorways. For railway segments, besides the railway section name also a bridge name and a tunnel name attribute are provided. In case of water segments, the official, Dutch and Frisian name attributes for the water body can be supplemented with a sluice name and a bridge name, for water segments of this water body that are part of these structures (Kadaster 2017). Obviously not all combinations are possible, but there are for example road segments with both a street name and a bridge name, or water segments with an official name, a Dutch name, a Frisian name and a sluice name.

In case of administrative and geographical areas, places and to lesser extent also functional areas, name attributes are a key element to distinguish features from each other. Generally, places, administrative and geographical areas are not or only to some extent visible in reality. They represent a unity of space that was set by government or exists in the perception of the population. There may be a link with the geomorphology visible in a topographic map, e.g. a populated place corresponds to a concentration of buildings, infrastructure, functional areas as sporting grounds and cemeteries, etc. However, without the name of the place it is hardly possible to identify and distinguish places.

Data collection

The collection of data in the BRT is mainly based on the interpretation of aerial images and 360-degree street view images. In the yearly update process of TOP10NL, as a first step, topographers compare the current aerial image with the aerial image of last year to detect relevant differences and mark them with a polygon as 'change triggers'. In a second step the triggered changes are processed in the TOP10NL database, which at that moment still represents the topographic situation at the time of the last year's update. For this purpose, in ArcGIS software a visualization of the TOP10NL database is overlaid on the current aerial image. The topographer assesses all change triggers and performs changes in the database to match it with the situation as displayed on the aerial image. In case of objects with a height, like buildings, stereoscopic images are used to overcome the influence of occlusion and to make sure the boundaries of an object are drawn on the right place.
For objects or attributes that are difficult to see and cannot be verified on aerial images, 360-degree street view images are used. These street view images replace the field surveys, which formed a structural part of the update process until 2009. When updating a map sheet, topographers used to go to the area and explore by bicycle every road to check for additional changes that were not visible on aerial images, or for objects and attributes that could not be verified. Building types, small design elements like road signs and culverts, forest paths and toponymic data are examples of data that were gathered during field survey.

As in 2009 nationwide 360-degree street view images became available, which are updated in a 1-year cycle and cover the vast majority of roads previously explored by topographers, it was decided to suspend the time-consuming and costly field surveying work and replace it as much as possible with street view image interpretation. For some aspects of the previous field surveying, street view images provided no solution. Especially for unpaved forest paths, invisible on aerial images due to vegetation, street view images are generally not available due to the restricted access of forests for motorized traffic. Therefore, cooperation is sought with forest and nature conservation organizations to let

foresters survey these forests and indicate relevant changes in the forests in a special user feedback application.

Another additional source of information for collecting data is provided by external databases, maintained by other governmental agencies or private companies. Examples of these external sources are the websites of religious denominations for the addresses of churches, mosques, synagogues and other religious buildings, or data of railway network agency ProRail for the locations and names of train stations as well as for several railway segment attributes, such as status and use. The land use type for terrain polygons representing agricultural parcels is based on the database with crop type registrations by farmers, which they provide to the Ministry of Agriculture, Nature and Food Quality as a condition for the granting of European agricultural subsidies.

To some extent, toponymic data can be collected by using these external data sources. For official place names and the spelling of street names, the Key Register of Addresses and Buildings (*Basisregistratie Adressen en Gebouwen*, BAG) is used. Special attention is paid to the correct registration and spelling of toponyms in the province of Friesland, for which lists of official place and water names are provided by the Fryske Akademy, an academic institute on the Frisian language. A description of all available external data sources can be found in Section 3.1.

For many toponymic data however, no alternative source was found or little or no attention was paid to keep these data up-to-date, as the impression was that hardly any changes occur. This is especially the case for most types of geographical areas, such as fields and regions, forests, heathlands and dunes, and polders. Toponymic data from other feature classes include water names, building names that are not verifiable on street view images, place and street names not present in the BAG, and names of many functional areas. For some of these toponymic data, an alternative way of data collection and maintenance by making use of crowdsourcing or VGI data sources might be a solution.

Currently, efforts are taken to improve the usability of the data in the BRT. One aspect of these is the conversion of features in the geographical and functional area feature classes from point to polygon features. Therefore, rules are needed to determine the boundaries of these features. In case of functional areas, rules can be based on topographic elements visible when interpreting aerial images. For geographical areas, it might be necessary to apply crowdsourcing by asking multiple users to provide suggestions for the boundaries of these areas.

2.3 Case study: built-up areas in the BRT

A successful example of the conversion from point to polygon features is the creation of built-up area features in the BRT. This project represented the first initiative to restart the updating of a specific part of the toponymic data since the discontinuation of the field work activities in 2009. It shows the possibilities for the use of external data sources, as well as its limitations and the potential for crowdsourcing as a supplement to these sources.

Background

Originally, at the introduction of the BRT, place names already present on the topographic maps were placed in the geographical area feature class and divided into three area types:

- populated place (*plaats, bewoond oord*)
- dispersed settlement (*buurtschap*)
- house grouping (*huizengroep*)

All features contained two separate name attributes to indicate a Dutch name and if applicable, a Frisian name, as well as an attribute to provide a number of inhabitants. The latter attribute however was not used, as the required statistics were no longer collected during field work visits and an alternative source was not directly available. Still, for the text size of place names on the map a classification relative to the number of inhabitants is applied, based on the last known figures. With continuous changes in the numbers in reality, the impossibility to adjust the text sizes quite soon became a problem. The solution for this gap in the data collection process was supposed to be found in the conversion to polygon features representing the built-up area with a corresponding number of inhabitants.

External data source assessment

One of the key principles of the key register system is to re-use existing data. Also, for cost and efficiency reasons this was preferential and thus several existing data sources were assessed, but all had their disadvantages:

- Place of residence (*woonplaats*) polygons in the Key Register of Addresses and Buildings (*Basisregistratie Adressen en Gebouwen*, BAG) comprise the area in which all addresses have the same corresponding place of residence. Both the names and the boundaries of the polygons are determined by the municipalities. The area usually combines the built-up area with the surrounding countryside. As a source for built-up areas this layer is therefore unsuitable.
- Legal built-up area limits are not identical in all legal contexts. The boundaries applied for the Road Traffic Act (*Wegenverkeerswet*) marked by the well-known blue place name signs at all roads entering the built-up area, may differ from the boundaries for the Roads Act (*Wegenwet*). The former law determines what traffic rules have to be applied on a road; the latter determines what authority is responsible for the maintenance of the road. Furthermore, different built-up area limits can be determined in the context of the Nature Conservation Act (*Wet natuurbescherming*), spatial planning, or the General Local Ordinance (*Algemene Plaatselijke Verordening*, APV). As there is no national database of these limits and many of them are only descriptive and not geometrically registered, they are unsuitable as a source for a national, consistent built-up area layer.
- The Central Bureau of Statistics (*Centraal Bureau voor de Statistiek, CBS*) maintains two data sets with spatial divisions at a level below the municipal division: the Ward and Neighborhood classification (*Wijk- en buurtindeling*) and a data set with population centers (*bevolkingskernen*). The former originates from the Census of 1947 and subdivides all municipalities into 'wards' and 'neighborhoods'. The division itself is determined by the municipalities, leading to a lack of consistency: most municipalities have separate 'neighborhood' polygons for the built-up area and for the surrounding countryside, while some use one 'neighborhood' for built-up area and countryside together. The population centers data set was created for the Virtual Census of 2001 based on automated algorithms, leading to illogical situations: one polygon for a whole agglomeration of populated places, separate polygons for occasional groupings of houses outside built-up areas and without a specific place name. These data sets are therefore both unsuitable as well.

Drawing boundaries

After some internal experiments with an automated generation of built-up area limits based on topographic elements failed, the only acceptable solution appeared to be the construction of built-up area polygons by hand, using aerial images and a set of rules prescribing the location of the boundary in a wide range of situations.

To secure the recognizability and usability of the data set, the boundaries on and near the roads are based on the location of place name signs, corresponding for places with blue place name signs with the built-up area limits according to the Road Traffic Act. In cases where 2 built-up areas touch each other the place of residence boundaries from the BAG are used to divide them.

Number of inhabitants

The number of inhabitants of the resulting polygons can be calculated by adding up the number of registered residents in the Key Register of Persons (*Basisregistratie Personen*, BRP) on all addresses within the area. While access to this registration is highly restricted due to privacy considerations, cooperation was sought with CBS which uses the BRP regularly to gather statistics. In a mutual agreement Kadaster sends the polygons to CBS, which calculates the number of inhabitants of each area.

In the BRP persons are registered as residents on a valid BAG address, while in the BAG every address has a geographic location. CBS analyses for each polygon what addresses are located inside its boundaries and adds up the number of persons registered on these addresses on the agreed reference date in the BRP to calculate the number of inhabitants of the area. As persons can also be registered on a berth, corresponding with a houseboat or floatable house in a water adjacent to the built-up area, and the polygon boundaries generally follow the shore line of the water in these cases, persons registered on a berth within 25 meters of the polygon boundaries are added to the number of inhabitants of the polygon. CBS returns these statistics for each polygon to Kadaster, which publishes the data with CBS stated as a source.

Place names

The first data set of 'topographic built-up areas' in the BRT based on 2013 aerial images was thus published in February 2015, after an internal data set based on 2011 and 2012 aerial images was already completed in October 2013. The Dutch and Frisian names of the polygons are based on the place names already registered in the BRT as a point feature, but adjusted to the spelling of the place of residence names in the BAG in case a built-up area has a homonymous place of residence in the BAG.

However, as legacy of the postal registration, that was irregularly adopted by the municipalities responsible for the data in the BAG, many places of residence names contain abbreviations indicating the province or municipality in which the place of residence is located, to distinguish them from homonymous places of residence elsewhere in the Netherlands. These additions might have been useful for postal processing, but are not necessary in the BAG as every place of residence has a unique identifier and a polygon geometry unmistakably showing the location. Therefore, many other municipalities followed the suggestion given at the creation of the BAG not to adopt these additional abbreviations.

In the BRT they are also superfluous and even disturbing in map visualizations. To maintain a consistent naming policy for all place names, the BAG names are therefore adopted without additional abbreviations. The same applies to abbreviations in the place names itself, for example if the word *Sint* (Saint), as in *Sint-Annaparochie*, is abbreviated to *St.-Annaparochie* in the BAG. The BRT always shows the full name in these cases.

Data structure

In the current BRT data model, version 1.2 as described in Section 2.2, a separate feature class exists for places. At the same time a new classification of place types has been introduced, replacing the former 3 area types. The model distinguishes 5 main area types for places:

- residential center (*woonkern*)
- industrial center (*industriekern*)
- recreational center (*recreatiekern*)
- hamlet (*gehucht*)
- dispersed settlement (*buurtschap*)

Additionally, 4 subordinate area types can be indicated:

- subordinate center (*deelkern*)
- city borough (*stadsdeel*)
- town ward (*wijk*)
- neighborhood (*buurt*)

The model also provides several attributes that give information on the status of the built-up area, being:

- built-up area (*bebouwde kom*), with value 'yes' if the place has blue place name signs and can be regarded as a built-up area according to the Road Traffic Act, or with value 'no' if there are white, other or no place name signs and no legal built-up area according to the Road Traffic Act.
- official name (*officiële naam*), provided only if the place name is a BAG place of residence name.
- BAG place of residence (*BAG woonplaats*), with value 'yes' if the official name is identical to the place of residence name in the BAG, or with value 'no' in all other cases.

Data delivery

In April 2018 the 6th version of the data set was published, based on aerial images of 2017. Meanwhile for all built-up areas with more than 100,000 inhabitants a full subordinate division has been made with a polygon feature for every object. Like the main area type features, also the subordinate type polygons have a number of inhabitants that corresponds with the number of registered residents within the area. However, for map visualization purposes only the residential centers (*woonkernen*) and subordinate centers (*deelkernen*) are displayed with a text size classified according to the number of inhabitants. Subordinate centers in this context represent places that used to be separate towns or hamlets, were swallowed up by the built-up area of a larger neighboring town, but are still topographically recognizable by a separate building structure, justifying the continuous presence of their place name on the map.

Currently, TOP10NL still contains point features for the 4 subordinate area types within built-up areas with less than 100,000 inhabitants. Also, for many hamlets and dispersed settlements where no place name signs indicate the boundaries of the place, no polygons could be drawn and point features remain. In these latter cases, crowdsourcing might be a solution to collect information regarding the commonly recognized area that belongs to the dispersed settlement or which buildings form part of the hamlet.

2.4 Requirements for BRT data

Kadaster Act

The legal basis for the existence of the BRT and the collection and maintenance of BRT data is the Kadaster Act. The role of Kadaster as the responsible agency is prescribed in Article 3: "the Agency has (…) the task of: (…) uniform, consistently and nationwide collecting, geometrically capturing, maintaining and cartographically displaying geographical data as well as maintaining and updating the Key Register of Topography" (wetten.overheid.nl 2018b).

According to the same Act (Article 7f, Paragraph 3), all data in the BRT "is authentic". A specific definition of authenticity is not included, but in the system of key registers the concept of authentic data is explained as data of high quality that can be used for tasks in the area of public law without prior examination on its reliability (Logius 2018). It follows that data must be verifiable at a reliable source before it can be included in the BRT.

Article 7j, Paragraph 2 of the Kadaster Act prescribes the responsibility of Kadaster to make sure "a geographical object included in the BRT (…) is in accordance with the physical reality at the time of the last update of the geographical area in which the object is present." This means that the actuality of an object in the BRT may not differ from that of other objects in the area. With respect to the toponymic data in the BRT, it can be interpreted as an obligation to maintain for these data the same update cycle as for other BRT data. As mentioned in the previous section, this is not the case for all toponymic data. Part of these data has no link with the 'physical reality', as the boundaries of many geographical areas for example are not visible in the terrain. Therefore, maintenance was not seen as a priority. Sometimes it was even questioned if something ever changes in geographical areas and if maintenance is really necessary. But given the situation that some toponymic data are not updated at all, their correctness and suitability can no longer be guaranteed and thus it is doubtful whether these data comply with the law.

Frisian language laws and regulations

With respect to geographical names in the BRT, special attention has been paid to the registration of names in the Frisian language. For a long time, Frisian names were not present on the maps made by the Topographic Survey. The agency even maintained a policy of translating Frisian names to Dutch whenever possible (Topografische Dienst 1968). Only since the 1980s, when some municipalities decided to officially change their names and the place names within their borders from Dutch to Frisian, the Topographic Survey changed its policy and these, now officially, Frisian names start to appear on the topographic maps (Topografische Dienst 1979).

In 1996, Frisian was recognized by the Dutch government as a minority language under the European Charter for Regional or Minority Languages. With this charter, the Dutch government undertakes, inter

alia, to "allow and/or encourage (…) the use or adoption, if necessary in conjunction with the name in the official language(s), of traditional and correct forms of place names in regional or minority languages" (wetten.overheid.nl 2018a).

When the BRT was set up, it was decided to allow for a separate Frisian name attribute for almost every feature class. In the current data model, Frisian names can be indicated for water segments, places, and administrative, geographical and functional areas. Currently, all official Frisian place and water names are included in the database, as well as all unofficial Frisian place names in municipalities were Frisian is used as an official language.

2.5 Requirements for toponymic data

The Netherlands currently has no law referring to the standardization of toponymic data. As mentioned before, for the orthography the 1947 spelling laws excluded the application of the Dutch spelling regulations to geographical names, but this exclusion has been repealed with the introduction of a new Spelling Act in 2005. In the current spelling regulations in this act no special attention was paid to the spelling of geographical names in the Netherlands.

On an international level, the standardization of geographical names has been well developed thanks to the work of the United Nations Group of Experts on Geographical Names (UNGEGN). In this UN body, scientific experts and governmental representatives from countries all over the world work together on solving problems with national and international standardization of geographical names. This includes the standardization of names in different scripts and writing systems. It also provides suggestions and recommendations for national standardization. In one of the first adopted UNGEGN resolutions in 1967, the UN called on member states to establish or designate a national names authority responsible for the national standardization of geographical names and setting up consistent rules and regulations for their registration (UNGEGN 2006).

In order to standardize toponymic data in the Netherlands, several issues have to be solved. For the names of some object categories other authorities are legally responsible for their registration. This is the case for the names of municipalities, and the names of towns, villages and streets used in postal addressing. All these names are the responsibility of the municipalities. They are included in the BAG, as they form essential elements in the address registration. Standardization measures will not apply to these names, unless an explicit agreement is reached between the parties involved in the maintenance of the BAG, which is a sensitive matter considering the huge impact changes in postal addressing have. Any changes in a currently registered name require a new formal decision to be taken by the municipal council.

In the data model of the BAG, street names are registered under the concept of 'public spaces' (*openbare ruimtes*), which leaves space for special types of address locations where no physical street is present. The town and village names are registered as 'places of residence' (*woonplaatsen*), based on the postal code division made in the 1970s. As a preparation for the introduction of the BAG in 2009, municipalities had to divide their territory into residence areas, in which every address has the same postal place of residence. Creating new places of residence in the BAG that did not already have their own postal code was discouraged; in an agreement between Dutch postal delivery company

PostNL and the Dutch government it was decided that municipalities had to pay to PostNL the costs for creating a new postal code and adjusting the postal administration (Staat der Nederlanden 2014).

As many places in the BRT do not have their own postal code, they are not included as a place of residence in the BAG, but fall under the place of residence area of another place. Standardization measures may apply to these place names.

2.6 Standardization rules and regulations

Spelling and orthography

As a basic rule for the orthography, the current Dutch spelling regulations as defined in the Spelling Act of 2005 can also be used for the spelling of geographical names. This seems to be in line with the removal of any exceptions for geographical names from the legislation. Compared to the current registration of names in the BRT, this already would imply a huge modification.

Based on the previous exception, most names are still written in the De Vries en Te Winkel spelling of 1863, officially introduced in the Netherlands in 1883. Characteristics of this spelling include the use in adjectives of –sch ('Nederlandsche' instead of the current 'Nederlandse') and double vowels ('Hooge' instead of 'Hoge'). The report of the Damsteegt commission on the standardization of geographical names from 1973, still available at the Meertens Institute, provides valuable additional rules and regulations, although some choices are based on specific 1947 spelling rules that have been changed in the newer spelling regulations (Nederlands-Belgische Woordenlijstcommissie Aardrijkskundige namen binnen Nederland 1973). In Section 3.6 more information is provided on the modernization of the internal rules and regulations for toponymic data, partly based on the report of the Damsteegt commission.

Area boundaries

For some categories of toponymic data, e.g. geographical areas representing field names, the rules for defining the boundaries of toponymic data need to be determined as well. When objects have no relationship with a specific topographic feature or group of features, no precise boundaries can be defined. The question is how to determine fuzzy boundaries in these situations.

In fact, the application of crowdsourcing might be the only solution in this case. By asking multiple volunteers to draw a polygon for the same area, it may be expected that some patterns in the boundaries can be discovered. The strongly deviating boundaries can be left out of consideration, applying a buffer distance for which the settings should be depending on the actual data set resulting from the VGI experiment.

For the boundaries that somehow show the same pattern, an average can be calculated to be the fuzzy boundary of the object in the BRT. It may be advisable to add meta information on the fuzzy character of the boundary for every polygon feature that was drawn up in this manner, as to prevent users from giving too much decisive value to these boundaries. Obviously, the source description of all features collected as VGI should indicate the data collection method used.

Conflicting information

A similar solution can solve a situation where conflicting names or feature types are indicated by volunteers. In cases where only differences in spelling occur, the orthography rules can be applied. When the names are really different, the boundaries indicate the same area and the attributes indicate the same type of object, the 'outlier' in the result should be left out of consideration. This implies the need for multiple entries to the same object. In exceptional cases where two names are in use for the same object, both names can be registered for the feature.

Apart from the opportunity to draw a new polygon, an option to endorse an existing feature would work well to maximize the response. Conflicts in the feature types indicated can also be handled by choosing the most frequently indicated type, as far as the type is related to the underlying topography.

If there are any conflict situations where neither of the alternatives clearly has a majority amongst the entries, or where there are too few entries to decide, additional research is needed. If the use of VGI as a source for toponymic data turns out to be successful, experienced volunteers could be given a higher status when they structurally provide valuable contributions.

3. Methods of toponymic data collection

3.1 Toponymic data sources

To be able to estimate for what toponymic data crowdsourcing might be useful, it is necessary to know what existing data sources containing toponymic data are available, what kind of data they contain, what their quality is and to what extent they are suitable as a source to maintain BRT data.

In this section all known sources are described, starting with the traditional sources used by the Topographic Survey in the map maintenance process and followed by new sources that came available in the last two decades, as part of the system of key registers, through the internet or because of other developments.

3.1.1 Traditional sources

In the course of history, only more recently governments systematically influenced the determination and registration of geographical names. Regarding street names for example, it was only from the French period that the first municipalities in the Netherlands became active in determining official names for all streets and giving all houses an address. This was done as a consequence of the establishment of municipalities and the new responsibilities they were assigned to, such as the registration of the population, as well as of requirements for new national governmental activities, such as the conduct of a census or the setup and maintenance of a cadaster (Dings 2017). Many geographical names, of all types and importance, date back from before the 19th century or arose later in the vernacular before they were first registered and codified in governmental administration.

Local population

In this context it may be no surprise that the local population has always been an important source of information for geographical names in the data collection process for topographic maps. This applies in particular to the names of hamlets and of dispersed settlements, the latter being a very common settlement type especially in the eastern parts of the Netherlands, as well as to field names.

Farm names also originate from this source, but unlike the field names they are usually present at the location, written on the façade of the building, and can be checked without further inquiry. Many historical farm and other building names however are only popularly known and may even differ from the name the current residents use. Especially in the eastern parts of the Netherlands farm names can have a very long tradition and comparable to the situation in Northern Europe, traditional surnames in the region are derived from them.

Maps being made for military purposes, it was important both for orientation and for verification to know as precisely as possible one's location. Settlement, area and building names helped in that and nowadays they still do. They also make it easier to identify and describe areas and communities, both for planning and policy making as well as for the inhabitants and owners. Not in the least they also have cultural value, being part of the local or regional heritage, and can be used for historical research. These names for small-sized objects are also known as microtoponyms.

Local government

A second important source of information for map makers regarding geographical names are local governments. Traditionally, in the Netherlands there are in fact two local governmental levels.

The municipalities are responsible for the names of settlements and roads within their area. Therefore, topographers paid a visit to the local government offices during their field work activities and tried to verify the names of settlements and streets. Additionally, they requested the number of inhabitants of every populated place. Topographers also purchased a municipal guide (*gemeentegids*) and a map with a street plan (*plattegrond*) of the municipality, in order to gather contact details and have a reference for inserting street names at the right place on the map.

As the municipality is regarded as the authority on local level, and as it is easier to verify names at one place, topographers also tried and asked the municipal officers to confirm names of hamlets, dispersed settlements, town wards, neighborhoods, and field names they had collected.

Originally, municipalities were closely connected to local society and its officers would be well acquainted with the area. Often also, municipalities would have a well-documented archive of the local history and could provide valuable information on all types of names. From the 1980s however, municipalities were increasingly merged into larger entities while efficiency and professionalization efforts led to a looser connection to local society, the divestment of local archives and historical research activities, and to more officers from outside the municipality or without insight in geographical names. Frequently, during the visit of a topographer to the town hall, as a source to check the names, municipal officers would try to resort to a copy of the very same topographic maps the topographer was busy updating.

The information on names of hamlets, dispersed settlements and town wards collected by the Topographic Survey served as input for a publication called *Lijst van Nederlandse Gemeenten* (List of Dutch Municipalities), edited by Mr. D. Vos and therefore informally called '*het boekje-Vos*' (the Vos booklet). The list was published by the Association of Dutch Municipalities (*Vereniging van Nederlandse Gemeenten*, VNG) and also used in commercial book series called *Alfabetische plaatsnamengids van Nederland* (Alphabetical Place Names Guide of the Netherlands) by subsequent publishers Van Goor, Vuga and Elsevier from 1948 until 2012 (KB 2018). It provided every municipality in the Netherlands with an overview of key statistics (area size, number of inhabitants, town hall address, etc.) as well as with a list of place names within the municipality.

The second local governmental level in the Netherlands is formed by the water boards (*waterschappen*), a typical Dutch form of government responsible for water management: maintenance of waterways and water barriers (mainly dikes), monitoring the water levels, drainage and water quality as well as sewage treatment. Even more than the municipal level, in the past 60 years the water boards went through an intense process of mergers, decreasing their number from about 2600 in 1950 to 260 in 1980, 26 in 2011 and 21 in 2018 (Unie van Waterschappen 2018).

Their importance for geographical names collection lies in the fact that they would have the names for local and regional water bodies they are responsible for: smaller rivers, streams, canals and ditches. Also, dikes and engineering constructions like bridges, tunnels, sluices and pumping stations are

maintained by water boards and usually have a name. In the northern and western half of the Netherlands, water boards, in Holland and Utrecht traditionally called *hoogheemraadschap*, artificially maintain the water levels of all the land in what nowadays are known as water level areas (*peilgebieden*). These areas often coincide with polders: areas of historical, governmental and water management interest that are surrounded by dikes or other water barriers, although sometimes several polders are later united into one water level area, while in some cases a polder has been split up into two or more water level areas (Steenbergen et al. 2009).

Many polders originally had their own water board; in fact, the oldest water boards originate from a cooperation of owners of houses and land to maintain dikes and canals and make agreements on the water level in the area. They constitute the oldest level of democratic government in the Netherlands. Polders have names that were traditionally shown on maps and where water level areas have a name, this name is usually derived from the polder's name or names.

Water boards cooperate in the Union of Water Boards (*Unie van Waterschappen*) and established a joint ICT organization, *Het Waterschapshuis* (The Water Board House). This has resulted in the creation since 2017 of a consistent national database of water-related features, the *Centrale Distributielaag* (Central Distribution Layer), which is still under construction (Het Waterschapshuis 2018; Unie van Waterschappen 2018). Data sets and web applications of individual water boards not always contain water names. Water boards rather use IDs to identify the objects they are responsible for, as not all objects have a name (PDOK 2018a).

Rijkswaterstaat

During the field work era, topographers frequented water board offices to a much lesser extent than town halls. This was because of the availability of a well-documented source for all water related names at the office of the Topographic Survey: the water management maps (*Waterstaatskaarten*) published by Rijkswaterstaat. These maps not only included the waterways, dikes, constructions and polders managed by the water boards, but also the waterways and features of national importance maintained by Rijkswaterstaat itself.

The first edition of these 1:50,000 scale maps was produced between 1865 and 1891, based on the topographic maps of the time. As the number of water boards at the time was still enormous, and as most of them were not able to produce these maps on their own, water management maps were an important source of information for all organizations and people with interest in water management, not in the least the water boards themselves. In the course of the 20th century, four more editions were published, the last one in 1990 (Steenbergen et al. 2009). Due to budget cuts and the fact that the maps were used more outside than within Rijkswaterstaat, the production of the *Waterstaatskaarten* was discontinued in 1992.

In order to still meet the demand, the information on the maps was digitized as the *Waterstaatkundig Informatie Systeem* (WIS, Water Management Information System), but maintenance of this database was soon discontinued as well (Rijkswaterstaat 2001). In more recent years, commercial water maps of travelers' association ANWB replaced the *Waterstaatskaarten* as a source for water names. Polder names however are not present on these maps. Instead, the municipalities were asked to verify them.

It is questionable however whether the ANWB maps and the municipalities could be regarded as an authoritative source for these water-related names.

For larger navigable waterways, another publication of Rijkswaterstaat remained important: *Vaarwegen in Nederland*, nowadays a digital product called Fairway Information Services. It provides a description of all navigable waterway routes in the Netherlands with kilometer indications, waterway connections, CEMT waterway classification, bridges, sluices and other obstacles, depths and widths, etc. The names of these waterways and of bridges and sluices can easily be derived from this overview (Rijkswaterstaat 2018).

Hydrographic Service

Offshore water names form a special category of water names. They include names of sea-lanes, sandbanks, shallow waters, estuaries, inlets, bays, capes and other coastal or maritime objects. Concerning the Dutch territorial waters, the responsibility for the collection and maintenance of offshore names lies with the Hydrographic Service (*Dienst der Hydrografie*), an agency of the Royal Netherlands Navy. The Hydrographic Service produces and publishes several nautical chart series, nowadays mostly in digital form (Dienst der Hydrografie 2018).

Traditionally the Topographic Survey uses the 1800 chart series for leisure craft and small commercial vessels as a source to collect and update the offshore water names on topographic maps. These series consist of 8 atlases, still published as paper maps only but provided as digital map files to Kadaster as well, covering the Dutch North Sea coast, the Wadden Sea and Eems-Dollard area, the IJsselmeer and adjacent lakes, and the Rhine-Meuse-Scheldt delta in the provinces of Zeeland and South Holland with all estuaries, including the ones dammed by the Delta Works. Besides nautical information concerning water depths, buoys, navigation lights, and sailing routes, many objects and areas in the waters and on the coast are identified with a name. In TOP10NL these names are present as either a water name or a geographical area name.

Nature conservation organizations

A last important source of information for geographical names traditionally used by topographers was the handbook of the *Vereniging tot Behoud van Natuurmonumenten in Nederland* (Society for the Preservation of Nature Monuments in the Netherlands, for short Natuurmonumenten). This nature conservation organization is only one, although one of the largest, land owners in the Netherlands and manages a large amount of nature reserves.

As a gift for members and a tool to know where one could go out and enjoy nature, it published a handbook with a virtually complete overview of all nature areas in the Netherlands regardless of their ownership, including a map showing the location, the name, some key facts, accessibility details and a short description of the area. Insofar as these names were not also present on signs at the entrances of the forests and terrains, the handbook at least made it much easier to collect them at the time when the internet was not yet available.

On the topographic map, many names of nature areas are included while officially designated nature reserves are indicated with the type name *natuurreservaat* (nature reserve) between brackets. Also, names of military training grounds and shooting ranges are indicated that way, and as most of these

are at least part of the time accessible for recreational purposes, they were described by the handbook as well.

The first edition of the handbook was published as early as 1949, the 8th and last one in 1996 (KB 2018). By the turn of the century several other large land owners, such as Staatsbosbeheer (State Forest Management Agency) and provincial conservation organizations, published their own guides and discontinued their cooperation to the handbook. Subsequently Natuurmonumenten decided to make a new edition in 2001 with only the terrains of Natuurmonumenten included, which nullified the added value of the publication. Especially the nature area names of smaller land owners, like municipalities and private estate owners, were much harder to collect and update from then on.

Even today on the internet, there is no website with a full overview of all nature areas in the Netherlands like the handbook gave before. The site www.natuurkaart.nl, an initiative of research institute Naturalis and Natuurmonumenten launched in 2005 to make a digital overview of all nature areas, was never completed and closed down in 2016 for cost reasons (Naturalis 2018).

The boundaries, based on cadastral parcels, and names of private estates (*landgoederen*) in the Netherlands are registered by the Netherlands Enterprise Agency (*Rijksdienst voor Ondernemend Nederland*, RVO). In accordance with the Natural Scenery Act of 1928 (*Natuurschoonwet 1928*, NSW), estate owners can apply for governmental subsidies to maintain their properties, in exchange for making the estate accessible to visitors. This is very lucrative and so, nearly all estates in the Netherlands are registered as '*NSW-landgoed*' and are publicly accessible. The data of RVO would be a valuable source for polygon features of the functional area type *landgoed* (estate) in the BRT. Unfortunately, the information is only registered in paper notary deeds and not directly usable. Only a list of estate names registered by RVO is digitally available (RVO 2018).

3.1.2 New sources

Since the end of the field work activities in the production process of the BRT in 2009, of all the aforementioned sources only the nautical charts of the Hydrographic Service remained available and are still in use today. A difficulty in the process to transform geographical areas from point to polygon features is to figure out the approximate extent of the areas to which these water names relate. Direct cooperation with the Hydrographic Service might be necessary, as this information is not present on the nautical charts, although the size, direction, spacing and form of the text on the maps do give some indication.

Meanwhile several new sources of information made their entry in the production process, while other sources are available and potentially suitable to collect and maintain geographical names in the BRT.

BAG

Without doubt the most important source of information for names is the BAG. Although it does not provide a location or geometry to the names registered as a public space (*openbare ruimte*), it is a key register and the official compulsory source for these names. Names of places of residence (*woonplaatsen*) do have polygon geometry, but as already described, these polygons include both the built-up area and the surrounding countryside and are thus not suitable to include in the BRT.

The vast majority of public spaces registered in the BAG, over 95%, are street names (Kadaster 2018b). In 2010, shortly after the compulsory use of the BAG went into effect, the street names already present in the BRT were matched with the BAG to make sure their spelling and orthography would be in accordance with the official names. Before, the Topographic Survey used its own consistent orthography rules for street names, which resulted for example in street names consisting of an adjective and a noun to be written as separate words (e.g. Rotterdamse Weg), whereas the municipal and now official street names are usually written as one word in these cases (e.g. Rotterdamseweg).

Names in the BRT that could not be matched with the BAG were sent as feedback to the municipalities, the source data holders (*bronhouders*) of all BAG data, with the request to register them as new additional names. While a considerable number of these names were indeed registered, it appeared that many municipalities were not interested in their registration or declared it was not possible to register them.

The former applied to names of streets and roads where no addresses are located. As most street names on topographic maps are placed along roads outside of built-up areas, it often happens that no addresses can be found along these roads. When the street name has no function for addressing and a public space cannot be given geometry, the municipality might not be motivated to register it in the BAG. The latter applied to street names of roads belonging to estates, nature areas and other terrains in private ownership that simply do not meet the definition of 'public space'. All these names remain present in the BRT.

In 2017 a project was started to supplement street names from the BAG in the BRT, as much as possible through automated localization. This requires the use of additional source data containing road geometries, such as the National Roads Database (*Nationaal Wegenbestand*, NWB) maintained by Rijkswaterstaat, and OpenStreetMap (OSM) maintained by the crowd, in combination with the BAG to make sure the spelling of the name corresponds to the name in the BAG.

Although the public space names registered in the BAG do not contain geometric information, it is possible to partly derive the location of street names through an analysis of street name patterns in the address locations in the BAG, as addresses do have a location and contain the street name. By assigning the street name in address locations to the nearest road segment in TOP10NL, the BAG itself can also be used to localize the street names of a part of the roads, predominantly in built-up areas. In the project several assigning methods are used with each of the three sources (NWB roads, OSM roads, BAG address locations) to link street names to road segments.

For road segments where a majority of these methods give the same street name as a result, this street name is assigned automatically. In 2018 the results of this automated procedure were added to TOP10NL, resulting in a street name coverage of nearly 40% of all road segments. An attribute field indicates whether the name originates from the BAG or not. Additional research and development to increase the coverage are still being discussed.

BGT

A possible source to verify if the aforementioned sources assigned the correct street name to a road segment is the Key Register of Large-scale Topography (*Basisregistratie Grootschalige Topografie*,

BGT). This data set was developed as successor of the Large-scale Base Map of the Netherlands (*Grootschalige Basiskaart Nederland*, GBKN), which was created as a digital map in the 1980s for planning and maintenance purposes at a scale level between 1:500 and 1:5,000. Since 2001 the GBKN covered all of the Netherlands, although it contained only line-based geometry data with hardly any attributes and very few features outside built-up areas.

Since 2008 the transformation towards an object-oriented vector data set BGT began, of which the data are developed and maintained by a variety of governments and agencies as source data holders (*bronhouders*), based on their ownership and responsibilities: national water and road features are maintained by Rijkswaterstaat, other water features and water barriers are maintained by the water boards, railway features by ProRail, provincial roads by the provinces, military properties by the ministry of Defense, agricultural parcels by RVO as part of the ministry of Economic Affairs, and all other features by the municipalities.

The data model consists of an obligatory part concerning data that must be collected and maintained, with few detail and attribute information, and an optional part concerning data that may be collected and maintained to enrich the data with information available, desirable or necessary for the source data holder. With a delay of almost 2 years, in October 2017 the BGT became available nationwide and from 2020 it is obligatory for all features to have the correct attributes.

In the obligatory part of the BGT, municipalities have to indicate with separate label point features the location of street names, which are linked to and thus can only be a public space name from the BAG. According to the data catalog of the BGT, these label point features serve only for orientation purposes in visualizations of the BGT (van den Brink et al. 2013b). The same way as the address locations of the BAG, these point features can be assigned to the nearest road polygon and serve as another source to verify if the methods applied to the other three sources (NWB roads, OSM roads, BAG address locations) resulted in the correct street name. The placement, amount and completeness of label point features in the BGT however are not consistent yet, so there are still some drawbacks when using these data.

The obligatory part of the BGT does not provide the possibility to register a geometry for public spaces from the BAG. In the data catalog of the BGT, it is stated that "the BGT sees this geometry as a responsibility of the BAG" (van den Brink et al. 2013b). This is a curious remark considering the fact that both key registers, BAG and BGT, were developed under the same ministry and appointed the same data source holders, the municipalities, to maintain data related to public spaces. A revised data model of the BAG went into effect in 2018 and still does not contain geometries for public spaces. In the data catalog of the BAG it is not explained why public spaces cannot be registered with a geometry (Kooij et al. 2018).

The optional part of the BGT data model, called IMGeo (*Informatiemodel Geografie*, Information Model Geography), does provide the possibility to register polygon geometries for public spaces as 'administrative area' (*registratief gebied*). However, "rules for the demarcation of a public space have not yet been formulated in this model", although the data catalog suggests that "the demarcation of the public space geometry can take place at the location where the name of the public space changes and on the sides follow the boundaries of the road segments it contains" (van den Brink et al. 2013a).

A link can be made to a label point feature in the BGT for the BAG identification number and the type and name of the public space, as these attributes are not provided for the polygon feature itself.

Potentially, these public space polygons would be the perfect source for street names in the BRT. And as the data model of the BAG provides the opportunity to register names for several other types of public spaces than street names as well, such as waters, terrains, civil constructions (bridges, tunnels, gates, etc.) and landscape areas, there is a potential for much more data. Unfortunately, the fact that it is included in the optional part of the BGT prevents them from being applied nationwide. In January 2018, just 396 public space polygons in two municipalities were registered in the BGT, out of a total of 277,270 public spaces in the BAG (Kadaster 2018b; Kadaster 2018d).

Moreover, the registered public space names of other types than street names demonstrate the urgent need for geographical names standardization. Precisely these names often overlap with several municipalities who, without national standardization rules and regulations, can each register the same name with a different spelling. Although the amount of public spaces of other types is still rather low, there are already examples of such spelling variants: the name of the main passage through the province of North Holland was registered by different municipalities in the BAG as "Noord Hollands kanaal", "Noordhollands kanaal", "Noordhollandsch Kanaal" or "Noordhollandskanaal" (Kadaster 2018b). The spelling that would be in accordance with the current Dutch spelling rules, Noord-Hollands Kanaal, is not even amongst them!

Frisian names

A disadvantage of the BAG compared to the BRT is that every named object, be it a place of residence or a public space, can only have one name, which is regarded as the official name. This is especially noticeable in the Frisian language area, where objects like places, waters and areas usually have both a Dutch and a Frisian name and where both names are also included in the BRT. It can vary from municipality to municipality and, as a result of municipal mergers, even from place to place, whether the Dutch name or the Frisian name is the official place name.

Since the first municipalities decided to 'frisify' their place names in the 1980s, both names are present on the map. Topographers used the names and their sequence on the place name signs as a source for the correct spelling as well as to indicate to a cartographer what name should be visualized first and what name second, between brackets. In the course of the years this procedure led to many mistakes.

Some municipalities applied a preferential policy for Frisian names to come first on place name signs, which subsequently became visible on the map, although the Dutch names, placed in brackets, remained the official ones. Also, topographers without sufficient knowledge of the Frisian language, and often with a rather hostile attitude towards the status of the Frisian language compared to their own dialect, misspelled some Frisian and even some Dutch names. Finally, some municipalities decided to leave the Frisian names off the place name signs, while several 'frisified' municipalities decided to no longer mention the Dutch names on the place name signs, leading to inconsistent naming on the map.

Formal complaints by municipalities and the provincial government were submitted to the Topographic Survey and Kadaster regarding this issue, and in 2008 it was decided to change the policy.

Both for place names and for water names, the registration and visualization of names in Friesland (*Fryslân* in Frisian and officially) were now based on gazetteers and a corresponding file geodatabase provided by the *Fryske Akademy* (Frisian Academy), a scientific research institute on Frisian language and culture. This coincided with the introduction in 2007 of Frisian or dialect names as the official water names in all municipalities on the mainland of Friesland, except for the municipality of Harlingen and the city of Leeuwarden proper. By the end of 2009, TOP10NL and all TOP25 map sheets of Friesland were revised with always the official name placed first and the alternative name second, in a smaller text size between brackets.

In 2015 the brackets were replaced by a new visualization, with Frisian language place names always placed in italics to discern them from the Dutch language places names in straight text, while for water names the alternative Dutch names were largely removed and are only still visualized as a second name for larger lakes. In 2017 the commission on Dutch exonyms of the Dutch Language Union (*Nederlandse Taalunie*) included geographical names in Friesland in its scope of work and published a gazetteer of Frisian names on its website (Nederlandse Taalunie 2018). It is obvious to synchronize these gazetteers with the names in the BRT and maintain the Language Union gazetteers as a source for geographical names in Friesland, at least as long as there is no national names authority for geographical names in the Netherlands.

Internet sources

Apart from the formal key registers BAG and the BGT, several other general sources for geographical names are available. On the internet most people nowadays use applications like Google Maps and Apple Maps or a web map application that is based on one of these. The names in these applications are not collected by the tech giants themselves, but retrieved from existing sources.

In the period before the BRT became open data, Google purchased TOPnamen, the gazetteer of the BRT, from Kadaster and used the names in applications like Google Maps and Google Earth. Using Google Maps as a source for updating BRT names is therefore not an option, even if Google also allowed users to contribute to the data in Google Maps. Apart from that, Google Maps is not a topographic map application and thus Google used only a selection of the names from the BRT, particularly the populated place names and water names. Geographical areas, like region and field names, were not copied and are not present in the application (Google 2018).

Navigation maps

Navigation and GPS equipment companies like TomTom and Garmin also use maps in their products. TomTom uses its own maps since it acquired and incorporated map making company TeleAtlas, while Garmin uses maps from a specialized map company called Here, formerly Navteq, which is currently in majority owned by a consortium of the German car manufacturers Volkswagen, BMW and Daimler.

Both TomTom's and Here's maps mainly focus on road data, but also on a wide variety of points of interest, basically all information that might be useful when travelling from A to B. Names include place names, street names, names of rest areas, petrol stations, companies, institutions, public and commercial facilities, attractions, viewpoints, etc. Although the maps are comparable to Google Maps, which is also available as a navigation app, and not intend to be topographically complete and correct,

other names may be included. Here maps for example contain water names and names of nature areas, the latter because they are seen as points of interest as well (Here 2018; TomTom 2018).

TomTom's map data is not freely available and cannot be reused as open data, but Here offers a free-to-use navigation app. Kadaster has examined the usability of Here's names in the update process of functional areas in the BRT, but surprisingly enough it appeared that for the relevant and assessed area types the data in TOP10NL was more complete than in Here and the names were not always consistent and correct. Nevertheless, the data might be useful as a 'trigger' to find new or overlooked objects.

VGI platforms

Other main sources of geographical names are in fact crowdsourcing initiatives, like OpenStreetMap, Wikimapia and GeoNames. They in turn re-use open data as well: OSM for example used TOP10NL to provide information on land use in its maps and therefore comes closest to a topographic map. Geographical area names nevertheless are still missing (OpenSteetMap 2018). Wikimapia and GeoNames are crowdsourcing platforms specifically designed for collecting toponymic data. They both use Google Maps instead of OSM as a background.

Wikimapia and GeoNames do provide all types of populated place and area names, and Wikimapia also many water names. On the sites, users can add a new name, add attribute information to existing names, such as other name variants or the number of inhabitants for populated places, and they can draw a polygon for area names. Wikimapia additionally links the names to a wiki-style encyclopedia with many links to Wikipedia articles (Wikimapia 2018).

In GeoNames the polygons for area names are fixed sized squares by default and a quick scan through the data of the Netherlands learns that the vast majority of area names are still visualized like that. In cases where someone took the opportunity to draw a polygon with the 'real' boundaries of the area, the level of detail shows considerable differences. Focusing on populated places that have place name signs and assuming that these signs are marking the right boundaries, the correctness of the drawn polygons is doubtful and leaves room for improvement (GeoNames 2018).

In Wikimapia less square-shaped polygons are found, but the object density and level of detail of names is lower than in GeoNames, except for ward and neighborhood names in built-up areas. Many polygons for place names show the same defects as in GeoNames, although some boundaries are quite detailed and look similar to those in the BRT. What is particularly striking about Wikimapia is the low level of activity on the platform. Most polygons were drawn many years ago, dissolved municipalities are still present in the map and thus, the community seems to be too small to keep the database up-to-date.

A more detailed discussion of crowdsourcing methods, including VGI platforms, is provided in Section 3.2.

Meertens Institute archives

Where the use of open crowdsourcing platforms creates concerns regarding the reliability of the data, one can expect that with scientific data collection and assessment based on crowdsourcing this issue is solved. The Meertens Institute in Amsterdam, specialized in scientific research on Dutch language

and culture, between 1948 and 2011 was the leading research institute on onomastics in the Netherlands. Over the decades it collected an enormous amount of data on personal and geographical names and organized these in physical card file systems. One of them is the field names archive, containing information of field names all over the Netherlands collected during field work activities by students and researchers of the institute (Meertens Instituut 2018b).

Just like the military officers and later topographers did for the names on the topographic maps of the Topographic Survey, they talked to local inhabitants to find out what field names exist and to which area the names related. Depending on the region, the level of detail of the data is impressive, as in many regions particularly field names relating to very small areas were collected. The concept of microtoponyms is very much appropriate here.

Unfortunately, the field names archive was never digitized. A project proposal to digitize the card files and make them easily accessible was launched in 2003, but due to budget problems it took some time before it actually started. A first pilot viewer with a small part of the data was made, before the entire project was stopped as a result of the decision to reorganize the Meertens Institute and dissolve the onomastics department altogether. Since then, most of the researchers in onomastics left the institute and only the physical card file systems remain.

It is difficult to assess the usability of this archive for the BRT. The scale-size of many names applies more to a large-scale database. It would be no problem to add all names in TOP10NL, but visualization on even a 1:25,000 map might not be possible in many cases due to a lack of space in relation to the size of the related area on the map. The greatest barrier for the use of the data, however, is the fact that they are not digitized, which makes it a very labor-intensive job to process the names in TOP10NL. Still it would be an enormous enrichment of the BRT and Dutch geo-information in general if funds and resources would be made available for this job.

Conclusion

All in all, many different sources for geographical names exist, each with their own characteristics and usability as a source for maintaining the geographical names in the BRT. As a general conclusion however, none of them covers all the geographical names present in the BRT and almost all of them have their drawbacks. This leads to the observation that an additional source is indispensable and crowdsourcing might be a solution.

3.2 Crowdsourcing methods

Introduction

The use or involvement of the general public in the collection of the most diverse types of data might seem a relatively new phenomenon, originated and made possible by the rise of the internet. But as mentioned in Section 2.1, using the knowledge of local inhabitants by asking them about existing field names in the area can already be seen as a form of crowdsourcing. This was done by surveyors and topographers during their field work activities long before computers were even used, let alone the internet existed. In the scientific world, public participation has a long history as well. Already in the 19th century volunteer observers performed surface weather observations in the United States that were used by the meteorological institute (Fiebrich 2009), while in ecological research the use of non-trained amateurs to collect information on specimens, rocks and other natural objects goes back for

centuries, although one could say that science in general was largely a matter of amateurs before the 19th century, even if they were trained and dedicated (Miller-Rushing et al. 2012).

Definitions and examples

The concept of crowdsourcing as a portmanteau of crowd and outsourcing was coined in 2005 and defined by Howe as "the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in the form of an open call. This can take the form of peer-production (when the job is performed collaboratively) but is also often undertaken by sole individuals. The crucial prerequisite is the use of the open call format and the large network of potential laborers" (Howe 2006).

Thus, in strict sense, this definition narrows down crowdsourcing to situations where the 'network of people' take over the work of an organization's own employees, while others interpret crowdsourcing in general as the use of the general public to perform production work for an established organization. The definition also leaves open whether this work is paid for or not.

In geo-information science, Goodchild introduced the term Volunteered Geographic Information (VGI) in 2007 to describe the phenomenon of "the widespread engagement of large numbers of private citizens, often with little in the way of formal qualifications, in the creation of geographical information, a function that for centuries has been reserved to official agencies" (Goodchild 2011). It presumes the work has a voluntary character and leaves open the question whether it concerns new activities or the outsourcing of existing work to the general public.

This is understandable, as many VGI examples deal with data that was never collected before and is very difficult or impossible to compile without the cooperation of a large number of volunteers. Most of them relate to the rise in the use and functionalities of smartphones, which in very large numbers are able to provide an almost endless variety of data about human behavior. Just related to location, they can for example provide insight in personal aspects, like how much we move and how many times we visit places, but also in patterns like most chosen routes, abandoned paths and locations and times where congestion most likely will appear. Other examples of relatively new types of VGI data include geotagging of photos and videos, reports on events like disasters or crimes as well as location-based social media activities.

The rise of VGI also led to mapping initiatives like OpenStreetMap. Large tech companies like Google successfully integrate VGI content into their map products to offer real-time information on traffic congestion, average visitor numbers in shops and other large venues, as well as user ratings of points of interest.

Crowdsourcing for national mapping agencies

National Mapping Agencies (NMAs), with their established working procedures and all the knowledge and experience to make professional maps, were not amongst the first to use VGI or to stimulate the collection of volunteered information. But the growing attention for VGI and the practical benefits eventually aroused the interest of NMAs.

In a European context research on and experience with public participation in all kinds of mapping was brought together in a project under the EU-funded program COST (European Cooperation in Science and Technology) called *Mapping and the citizen sensor*, with reference code TD1202. In this 'action', running from December 2012 to December 2016, scientists and mapping agencies cooperated and shared their knowledge and experiences on VGI. The book *Mapping and the citizen sensor* published in 2017 shows the results of their work and comes up with some new or enhanced theories (See et al. 2017).

In the book, VGI sources are generally categorized based on two main criteria: whether they fall within the traditional scope of NMAs and whether contributors consciously contribute to the VGI data collection. For the first criterion a distinction is made between framework data, which are usually collected by professionals of NMAs with a high level of reliability, and non-framework data that were so far not collected by NMAs. The second criterion distinguishes active from passive data collection, where active data collection means contributors collect the data with the VGI purpose in mind, like adding features to OpenStreetMap, while passive data was created for other purposes but re-used as VGI, like geotagging messages, photographs and other social media activities (See et al. 2017). The two criteria and examples of each of the four resulting categories are visualized in a schema (Figure 5).

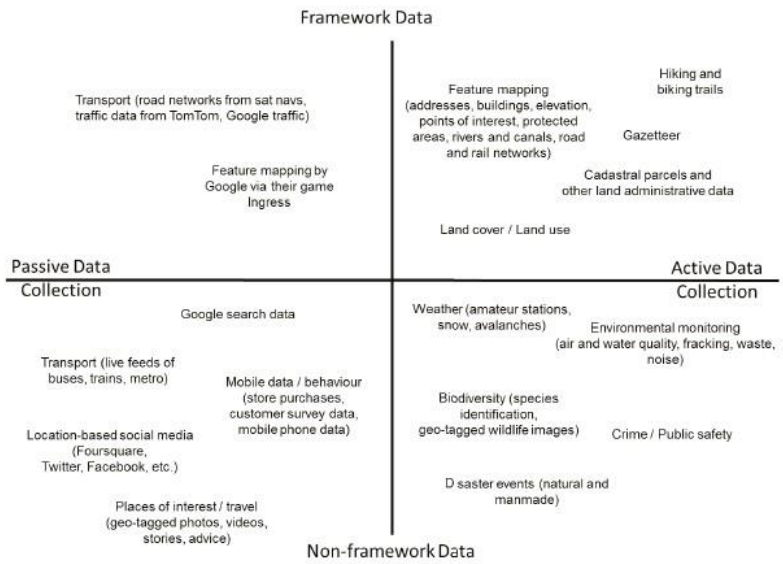


Figure 5. VGI categorization according to See et al. 2017.

Focusing on framework data as the most relevant half for NMAs like Kadaster, examples of active framework data include OpenStreetMap and Google Maps for general mapping, GeoNames and Wikimapia for geographical names data, mapping cadastral boundaries and properties in developing countries, mapping land cover and land use with the help of freely available satellite and aerial imagery, as well as mapping hiking and biking trails. Passive framework data include the information which mobile applications like Google Maps and other navigation apps collect about travel speed and roads that are used, as well as the Ingress game, an augmented reality science fiction play that asks players, in their quest to conquer portals, to photograph features and locations and thus unconsciously help to improve Google Maps data (Olteanu-Raimond et al. 2017b).

In a chapter on experiences of and recommendations for VGI in national mapping agencies, which was also published as a separate article (Olteanu-Raimond et al. 2017a), several methods of VGI use by NMAs are discussed. These are based on experiences of several European NMAs in the past decade. The methods can be summarized into three main categories:

- User reporting of both errors and changes
- Change detection techniques with existing VGI data
- Direct contribution of volunteers through new VGI data collection

Several NMAs also gained experiences with VGI related to geographical names, which is described in Section 3.5.

User reporting

User reporting is the most popular method and applied in most European countries involved in the research project. It is usually adopted in the form of a user feedback system, like in the Netherlands all key registers for geo-information must have a user feedback facility (*terugmeldvoorziening*) in which users can report errors or updates regarding the information in the registration.

When the BRT was introduced as a key register in 2008, a feedback system was established which required users to register first, acquire a user name and a password and sign in to the website before they could actually submit a report. At that time the BRT was not yet published as open data and thus all users of the data were known and registered customers, most of them with a long relationship and presumably a great experience in the use of topographic information. Nevertheless, the threshold to submit reports was relatively high, despite the legal obligation for governmental users to report errors found while analyzing or viewing the data. Only a few dozen reports per year were received, often from a few very active contributors.

After the BRT in 2012 became open data, Kadaster soon realized that the potential for user feedback was a lot bigger than could be achieved with the existing system. In 2014 a more user-friendly version of the user feedback system was introduced, in which prior registration was no longer necessary. Also, all reported errors and changes became visible on a map to everyone, including the status of processing of the report. Internally, it was agreed to check and process reports as soon as possible, depending on the ability to verify the report with the most recent aerial photographs or other relevant sources, so that in the ideal circumstance the situation in TOP10NL and on the map is already adjusted in the following release of the BRT.

This approach appeared to be very successful and the number of reports increased dramatically, to many hundreds per year. The new user feedback system was taken as an example for other key registers and in 2016 a new version was introduced, *Verbeter de kaart* (meaning both Improve the map and Correct the map), extending its application to the BGT.

Other examples include the Tell OS platform of the British Ordnance Survey (OS), the report option in the SIGNA Geoportal of the *Instituto Geográfico Nacional* (National Geographic Institute of Spain, IGN España) and a similar option in the Karttapaikka web map application of the *Maanmittauslaitos* (National Land Survey of Finland, NLS) (Olteanu-Raimond et al. 2017a).

Direct contribution of volunteers

In France, the *Institut national de l'information géographique et forestière* (National Institute of Geographic and Forest Information, IGN France) has several applications that allow for reports and contributions from both citizens and professional partners, like fire services and post offices. In a new proposed system, these incoming data flows are integrated into a single community and citizen sourcing portal, combining user reporting of citizens and direct data contributions from professional sources on a copy of the topographic database. Both are first checked and validated by surveyors before processing in the authoritative databases (Olteanu-Raimond et al. 2017b).

Direct contribution of volunteers is also proposed in Finland, where NLS plans to build a citizen's layer in which users can draw or import points, lines and polygons themselves. In a distant past, cadastral parcel boundaries in Finland were already collected through the help of owners, with a relatively high level of precision (Olteanu-Raimond et al. 2017a). In 2016 a new concept was launched by Kadaster and also ran as a pilot in Finland to let primary school children collect data in their own living environment, as part of the school curriculum for geography. While the project from a scientific point of view was very interesting, generated very enthusiastic reactions and in general the teaching package helped in sharing knowledge and insight in the work of a national mapping agency, the added value and usability of the data for the BRT was very limited.

Change detection

Change detection in most cases relates to the use of data from existing VGI platforms like OpenStreetMap, by analyzing and disseminating relevant changes to the topography and using them in the update process of the NMA's authoritative database. Only a few agencies have gained experience with this. The German *Bundesamt für Kartographie und Geodäsie* (Federal Office for Cartography and Geodesy, BKG) uses OSM to find new objects and object types, like buildings, structures, roads, names and points of interest (Olteanu-Raimond et al. 2017a). Kadaster has performed a pilot project to use a combination of the National Roads Database of Rijkswaterstaat and the roads in OSM to make a change detection layer that could be used as a 'trigger' for topographers to know where to find and process changes in the topography of the BRT. Although the pilot was successful and the layer has proven to be very useful in the update process, in the meantime a new procedure to find changes in aerial imagery by comparing the current and last aerial images was introduced and had become so efficient that the added value of a change detection layer was no longer present.

Workflow and contributors

With respect to the use of VGI, Olteanu-Raimond et al. (2017b) give some recommendations to successfully set up a VGI workflow. A user-friendly platform to contribute, with a clear purpose and simple tools, is a key element. This platform should enable both user reports as well as direct data collection. Quality control of any type should always be part of the workflow, creating a qualitative version of VGI (Q-VGI) that can be used in authoritative data sets of an NMA (Figure 6).

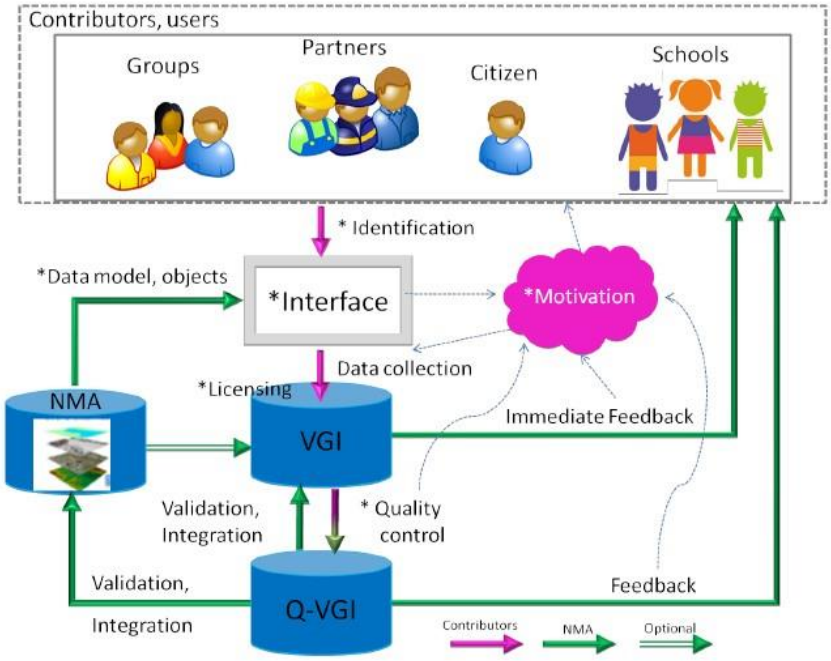


Figure 6. VGI workflow schema as proposed by Olteanu-Raimond et al. 2017b.

Regarding the VGI contributors, four different categories are distinguished: individual citizens, citizen groups, school children and professional partners. It is disputable whether the latter two categories can be regarded as real volunteers, as their contribution is arranged in cooperation with their superiors and takes place as an assigned activity under school or work time. The methods for data collection might be comparable to those applied to individuals or groups of citizens, but the resulting data do not fully meet the definition of VGI.

3.3 Suitability of crowdsourcing for toponymic data collection

With the exception of administrative data, typically determined by governmental bodies, or data requiring specialized knowledge and equipment to collect, e.g. bathymetric information such as isobaths, most data in the BRT is theoretically suitable for crowdsourcing. Many toponymic data are part of that. In particular names of hamlets and dispersed settlements, as well as regional names are very eligible for this.

Looking at the three methods of VGI data collection and the current practice, one can immediately conclude that user reporting for toponymic data is already taking place. The joint BGT-BRT user feedback system gives the opportunity to report errors or changes for all object categories in all BRT products, ranging from the TOP10NL database to the 1:25,000 (TOP25) to 1:1,000,000 (TOP1000) maps. Although it is not registered to which object category the report relates, the experience is that a significant part of the reports deals with toponymic data. For example, it can be an error in the spelling or location of a street name, a suggestion to add a new bridge or nature area with a name, or an inconsistency in the use of the Dutch or Frisian name of an area on different map scales (Figure 7).

Figure 7. Screenshot of the user feedback system Verbeter de kaart (Improve the map or Correct the map), with a user report requesting to add the missing name Witte Paal in TOP10NL for an expressway junction between Ommen and Hardenberg. Kadaster, as the source data holder (bronhouder) for the BRT, replied that the name is present in TOP10NL and will appear on the TOP25 map in the next release.

All these user reports contribute to the improvement of the accuracy of the BRT and the status as authoritative data set for topographic information in the Netherlands in general, together with the BGT, and for toponymic data in particular. On the other hand, the experiences of Kadaster employees using the BRT products and finding or suspecting quite some errors in the geographical names, as well as the number of corrections from local historical societies in the process described in more detail in Section 3.6, lead to the conclusion that additional efforts to keep toponymic data up to date are necessary. Providing a platform to report errors or changes and passively wait for contributions to come in is not enough. Or to put it in other words: if it is necessary to actively collect and maintain the data from other object categories, it is necessary for toponymic data as well.

As described in Section 3.1, there are many existing sources for geographical names. As far as toponymic data in the BRT that are not provided by authoritative data sets like the BAG, are concerned, existing VGI data might serve as a source to use in change detection. It is however no option to rely on them, as they are either insufficiently updated (e.g. Wikimapia) or not accurately enough (e.g. GeoNames). Nevertheless, for specific purposes, such as localization of BAG street names with the help of OpenStreetMap, the use of VGI sources may still be adequate.

Given the disadvantages of these first two methods, it may be no surprise that direct contribution of volunteers through new VGI data collection, the third method of VGI use in NMAs mentioned in Section 3.2, in advance seems the most promising alternative. This provides the opportunity to approach potential contributors with a specific request tailored to the needs in the BRT maintenance process. As with any crowdsourcing method, it is important in this to work well on the workflow, define strict rules and regulations for the registration of the data and build in sufficient number of quality checks, but also to take the motivations for the volunteers to contribute into account.

An example of the participation of citizen groups, a specialized crowd, in the maintenance process of the BRT is described in Section 3.6.

3.4 Toponymic data in other national mapping agencies

Toponymic data are an indispensable part of every topographic database. It follows that every national mapping agency (NMA) has established methods and procedures to collect and maintain data related to geographical names. It can be instructive to see how other NMAs have integrated toponymic data in their workflow. Since there has been no international comparative study yet on the way NMAs handle toponymic data, for this purpose three countries have been selected to describe policy and practice in more detail: Sweden, Switzerland and Belgium. These agencies share with Kadaster their geographical proximity, their limited size in terms of mapping departments, and their level of technological development.

3.4.1 Sweden

Just like Kadaster, the Swedish Lantmäteriet is responsible for the cadastral division of the country, the land ownership registration as well as for providing geographical information. As NMA it produces topographic maps at scales between 1:10,000 and 1:1,000,000. The 1:10,000 map shows individual buildings and even yard boundaries, which in the Netherlands are usually associated with the large-scale topography of the BGT or cadastral maps. The update frequency of the maps however is much lower and depends on the importance of the area and the amount of expected changes. In 2018 some map sheets were last updated in 2013 or earlier, while other map sheets were updated in 2015 or 2016 and are again updated this year (Lantmäteriet 2018a).

According to the Swedish Cultural Heritage Act (*Kulturmiljölagen*) the geographical names approved by Lantmäteriet must be used by state and municipal authorities in their approved form (Sveriges Riksdag 2018). This already implicates that Lantmäteriet is the names authority for Sweden. There is a separate Place Name Council (*Ortnamnsrådet*) with representatives from different governmental agencies, universities, the Institute for Language and Folklore and the Sami minority parliament that works together with Lantmäteriet to establish 'good place name practices', meaning the definition of rules and procedures for the registration of geographical names. The Institute for Language and Folklore (*Institutet för språk och folkminnen*) and the National Heritage Board (*Riksantikvarieämbetet*) advise on the registration of the names themselves. In practice, municipalities are responsible for most geographical names, like street names and names of wards, schools and sports facilities. Other names are collected by Lantmäteriet itself during field work activities, usually with the local population as a source. All names however have to be approved by Lantmäteriet, particularly with respect to the orthography, and registered before they become official (Lantmäteriet 2018b). This ensures a strict standardization of all geographical names according to the current Swedish spelling rules, but without

changing long-established names unless there are very good reasons to do so. In minority language areas, where Sami or Finnish (Meänkieli dialect) is spoken, names in Swedish and the minority language must be used simultaneously (Sveriges Riksdag 2018).

3.4.2 Switzerland

Swisstopo, the *Bundesamt für Landestopografie* (Federal Office of Topography) is the national mapping agency of Switzerland. It is responsible for the geographical information and for the national coordination of cadastral surveying, but not for land registration. It produces maps at scales between 1:10,000 and 1:1,000,000. The basis for all topographic map products is the large-scale 3D Topographic Landscape Model (swissTLM3D), which for most object categories is based on data collected in a 6-year update cycle. The third dimension is particularly relevant for analyzing purposes and 3D visualizations and very useful in mountainous areas (swisstopo 2018b).

Switzerland is a federal country and the responsibilities for governmental tasks are usually divided between the national authorities and the cantons. This is also reflected in the organization of the collection and maintenance of geographical names. The federal Ordinance on geographical names (*Verordnung über die geografischen Namen*) of 2008 assigns Swisstopo with the issuing of general toponymic guidelines, based on the recommendations of UNGEGN, as well as with the issuing of rules and regulations for the names in the topographic landscape model and on the topographic maps. On top of that, it issues recommendations for the orthography of municipal names, populated place names, street names and building addresses, while the Federal Office of Transport (*Bundesamt für Verkehr*) issues regulations for the orthography of station names. The names themselves are determined by the responsible cantonal agencies, on the advice of a cantonal naming commission (*Nomenklaturkommission*), and subsequently verified, approved and registered by Swisstopo or, in case of station names, by the Federal Office of Transport (Bundesrat 2018).

Due to multilingualism many topographic objects have more than one name, sometimes even in the same language. Therefore, the topographic landscape model provides the opportunity to officially register multiple names for an object. The federal ordinance does not regulate the registration of field names (*Flurnamen*). These are collected and maintained by cantonal agencies and used by Swisstopo in its topographic products. Due to their vernacular character, most of them are registered in one of the many local or regional dialects, especially in German-speaking Switzerland, and thus follow dialectical orthography rules (cadastre.ch 2018; swisstopo 2018a).

3.4.3 Belgium

The National Geographic Institute of Belgium (NGI, *Nationaal Geografisch Instituut*, *Institut géographique national*, *Nationalgeographisches Institut*) is responsible for the national geographical information of the country. In practice, it offers maps and products at scale levels between 1:10,000 and 1:400,000 (NGI 2018c). For the digital web service Cartoweb, the most recent data is provided. In 2018, depending on theme and map sheet the last update of the data visualized was between 1988 and 2017. For constructions, roads, hydrography and administrative data all map sheets were updated between 2013 and 2017. Street names were updated in 2017, other toponymy was updated between 1991 and 2016 depending on the map sheet (NGI 2018a).

The collection and maintenance of most toponymic data is not legally regulated. In absence of that, the NGI determines rules and regulations for the registration of names in its maps, based on and in

accordance with the extensive Belgian language legislation. For the orthography of names advice is obtained from the Royal Commission on Toponymy and Dialectology (RCTD, *Koninklijke Commissie voor Toponymie en Dialectologie*, *Commission Royale de Toponymie et Dialectologie*, *Königliche Kommission für Toponymie und Dialektologie*), established by the Belgian government in 1926 with the task to supervise research on toponymy and dialectology and to advise the government on toponymic issues. Already before World War II on the initiative of the Flemish section of the commission the municipal names in Flanders were adjusted to the then current Dutch spelling rules of De Vries and Te Winkel (RCTD 2018). After the war, the names were adjusted again according to the spelling reform of 1946. In the course of the decades all names on the maps of the NGI in Flanders were standardized to the current Dutch orthography rules. The Walloon section of the commission is more focused on the etymological orthography of names and thus the names in Wallonia show less variation in the course of time, although field names usually adapt to the current French orthography rules (NGI 2018b).

For the update of geographical names in its maps, the Bureau for Information and Toponymy of the NGI performs extensive research in cooperation with local contact persons, who are appointed by the municipal government at the request of the NGI. The mapping agency compiles a list of geographical names for each municipality, based on the names already present on the maps, names from specialized external sources, names collected during field work visits of NGI employees and names provided by governmental agencies, like the Flemish and Walloon forest management agencies for the names of nature reserves, forests, remarkable trees and field names within their areas. This list of geographical names is submitted to the contact persons, who review the list and agree with the name or propose an alternative orthography. They can also propose and add additional names to the list. The NGI verifies the names, seeks advise from the RCTD and registers the names in its topographic products (NGI 2018b).

Due to the federalization of Belgium from the 1970s onwards, the responsibility for determining municipal names, as part of the supervision on local and provincial government, was transferred to the regional governments of Flanders, Wallonia and Brussels. Federal laws still prescribe the official exonyms for Belgian municipality names, which must be used in all official publications and on all signs in the language area that corresponds to the language of the exonym. Municipalities are responsible for determining the street names on their territory. According to the Flemish Act on the Central Reference Addresses Database (*Decreet betreffende het Centraal Referentieadressenbestand*), street names are registered in the Central Reference Addresses Database (CRAB) maintained by the Flemish Agency for Information (*Agentschap Informatie Vlaanderen*, AIV), the regional mapping agency of Flanders. AIV is also responsible for the Large-scale Reference Database (*Grootschalig Referentiebestand*, GRB), a data set comparable to the BGT, that serves as the base map of Flanders and shows the street names and addresses from the CRAB (AIV 2018).

3.4.4 Other countries

Many other countries in Europe have established structures, legislation and processes similar or comparable to the examples in Sweden, Switzerland and Belgium. In general, there is a formal or informal agreement in all countries on the responsibilities regarding the collection and registration of geographical names. The national mapping agency is usually responsible for the registration and visualization of data, either through own field work activities or in cooperation with regional or local governments or organizations. Standardization of the names, by means of rules and regulations for the

orthography, is often done by a commission within the NMA or by a commission with representatives of all parties involved in the naming process. Looking at the examples of other countries allows the Netherlands to determine a best practice and setup a naming policy adapted to the present structures and circumstances without losing the goal of a consistent registration with regular updates out of sight.

3.5 Experiences in crowdsourcing toponymic data

In Section 3.2 various examples of VGI within national mapping agencies have been given. Many toponymic data lend themselves perfectly for crowdsourcing and some NMAs already gained experience with this. Particularly names that are not yet officially registered are very suitable for VGI data collection.

In Sweden emergency services requested Lantmäteriet to densify the number of registered place names in urban environments. Many objects have a formal name, which might be collected from name signs or from existing data sets, such as a list of schools. But in everyday language there are also quite some unofficial, vernacular names in circulation for all kinds of objects. When people call on emergency services in panic and want to explain their location, they may often refer to these vernacular names. In 2011 Lantmäteriet decided to test the potential for crowdsourcing and developed a smartphone application to collect these names. It ran a pilot project within its home town Gävle with the app PlatsNamna, meaning 'place naming'. On a background map one could search and find an object or location to name, and place a marker, at which point the application asks to provide the name and shows a form to register one's name and e-mail address (Roos 2012). Through media articles Lantmäteriet sought attention from both the general public and members of professional organizations and in the end many colloquial names of objects in Gävle were collected. However no follow-up was given to the project, as it seemed difficult to verify the correctness of the names and it was questioned whether such names should actually be part of an official topographic database (IGN 2014). Commercial names for example, can be very common in the vernacular and very useful for emergency services, but are generally considered undesirable in national mapping, to preserve neutrality and to prevent advertising.

A project with a similar background runs in the United Kingdom, initiated by the Ordnance Survey, the British national mapping agency. Here the Maritime and Coastguard Agency (MCA) sought contact with the request to share expertise in the collection of geographical names that people know and use locally. Obviously, the MCA was interested to know the nicknames of rocks, beaches, shores and other coastal and maritime objects that people may use when they call on the search and rescue services of the coast guard. In 2012 Ordnance Survey developed an application called Fintan, which allowed coastguard employees and their local volunteers to enter, locate and classify names they know are locally in use (OS 2012). The project is very successful and by the end of 2017 Fintan contained over 6,000 local nicknames of coastal landmarks along the British coast. Apart from that, the MCA also has access to the maps and data of OS with nearly 500,000 established coastal names. With more than 20,000 rescue operations in 2017 the Fintan data are used regularly by the agency, enable a faster response and potentially save lives. Therefore Ordnance Survey considers extension of the application to all emergency services in Great Britain (OS 2018).

In Spain in 2013, a VGI application was presented by scientific researchers using the data of the NMA with the purpose to improve the quality of the toponymic data. In order to eliminate errors in the

official place names database of IGN España, the VGI application was developed as a town conquer game in which users could 'win' a town by providing its correct name. This way, especially in bilingual regions of Spain errors in the database's names could be found and corrected (Castellote et al. 2013). Although a pilot project with the application in Castellón showed promising results, the project was not continued (Haklay et al. 2018).

Ordnance Survey, IGN Spain and many other NMAs in Europe, such as the agencies of Denmark, Finland, France, Iceland, Norway and Serbia have some sort of user feedback system through which users can report errors or changes to the map (See et al. 2017). Usually there are no restrictions with regard to object categories, so errors or changes in toponymic data can also be reported. In some countries, like Denmark and France, NMAs use an application to give partner organizations the opportunity to contribute to the collection and update of geographical names. In Denmark for example, the Agency for Data Supply and Efficiency (*Styrelsen for Dataforsyning og Effektivisering*, SDFE) has a general user feedback system to let users report errors and changes, and on top of that a special reporting application for geographical names. The latter application is aimed at local and national public organizations, such as municipalities, but it is also open to others. All users do have to log-in using their NemID, the digital personal identification system of Denmark that is linked to a citizen's official personal identification number. This geographical names feedback system (*Danske Stednavne Indberetningsportal*) is linked to the official Danish place name database, that contains not only the location of names present on topographic maps, but also of other names that can be used for routing, by emergency services, environmental agencies and others. With the help of particularly the municipalities, SDFE tries to keep the database up-to-date and complete (SDFE 2018).

3.6 Case-study: updating names with the help of local historical societies

At the time when field work activities were still current practice, municipalities were one of the most important sources for the Topographic Survey regarding the update of geographical names. As described, also in other countries NMAs use to work with local governments to collect and update toponymic data. In this sense it was in line with expectations to try and cooperate with municipalities to resume the maintenance of geographical names in the BRT.

First pilot project

In 2016, seven years after the last field work activities, a proposal was made by the Topography section in the Geo-information department of Kadaster to get in contact with municipalities and let them check the geographical names in the BRT. Some hoped to do this by visiting town halls again, but it soon became clear that for cost reasons this would be no option. Instead it was foreseen to make contact via the regional account managers of Kadaster, who have the responsibility for business contacts with municipalities in a certain part of the Netherlands. This evolved into a pilot project, which was carried out in the first half of 2016.

In cooperation with several account managers, nine random municipalities across the Netherlands were selected and approached with the request to cooperate. A special 1:25,000 map for each municipality was made with all geographical names accentuated, as well as an explanatory letter and a short manual with instructions on what names to check and how to check them. After these documents were delivered to the municipalities by the account managers, expectations about the results were high. But these soon turned out not to be fulfilled. Several municipalities did not want to

cooperate, while others postponed the work and never sent anything back. One municipality made it easy for itself by saying there had been no changes in the names within the municipality. In the end, only two municipalities made the effort to edit and return the map. One of them only checked and amended street names, which was far from a sufficient basis to update all toponymic data. Just one municipality out of nine followed the instructions, checked almost all names categories and provided a suitable result (Hogerwerf 2017).

Second pilot project

Obviously, this was a disappointment and let to skepticism about the possibilities to sufficiently maintain toponymic data anyway, unless the field work activities would be reintroduced. Nevertheless, a new pilot project was proposed in which the role of the municipalities would be replaced by local historical societies, hoping that they would have more knowledge and interest in checking and updating the geographical names in the BRT. Historical societies exist in all parts of the Netherlands and are usually organized on a local level. They consist of volunteers with special interest in the history of their own living environment and aim to do research, share knowledge and preserve local history. Many have a village, a municipality or former municipality as their working area, although there are also larger regional societies and umbrella associations on provincial level.

In the fall of 2016 a pilot project ran with seven local historical societies across the Netherlands. They received a special toponymic map with a textless TOP25 map as a background and a selection of geographical names in TOP10NL as well as nameless features of selected feature types that one could expect to have a name, such as sporting grounds and windmills, laid over it (Figure 8). Two Frisian societies received an additional map with the official, Dutch and Frisian names of all populated places and waters in the area. As in the pilot with the municipalities, an explanatory letter and a short manual with instructions were included.

Figure 8. Example of a toponymic map for the historical society on the former island of Sint-Philipsland.

In the end, six out of seven societies responded and returned the map with a large number of changes and additions. One society even added more maps with additional names. The seventh society still has not returned the map as of June 2018, but recently promised to work on it in the fall of this year. All maps received were assessed by an experienced topographer, who found little or no errors in the reported names as far as he could verify. This was considered a great success and in March 2017, it was decided to expand the project to all local historical societies in the Netherlands.

New workflow

As preparatory steps, the internal *Namenboek* (Names Book) with guidelines for the registration of names had to be renewed and a new workflow needed to be set up. Two employees were made responsible for the contacts with all historical societies, while a selected group of experienced topographers and former cartographers were designated for verifying and processing the changes delivered by the historical societies in TOP10NL and subsequently in the annotated text of the smaller scaled maps. All societies first received a written request for cooperation, followed by a phone call with a further explanation of the purpose and process. If they agree to participate, they receive the special toponymic map as desired either as a paper map in a tube by regular mail or as a pdf file by e-mail. The attached letter contains the request to check all the names on the map, possibly add any missing names and for area names indicate the approximate boundaries of the area. After some time, another phone call is made as acknowledgement of receipt and to know if there are any additional questions.

Upon return from the society the edited toponymic maps and all appendices are scanned and made available to the topographers for processing. They verify the contributions, as far as possible, and change or register the names as indicated by the society. If they decide to deviate from the information delivered by the society, this is noted on a special form. After completion, a new toponymic map is produced as pdf file on which all processed changes are visualized. This is sent as feedback to the society, together with the special form, with the request to check the names a last time. If no further comments are received, the changes are finally posted to the TOP10NL database and subsequently the annotated texts for the TOP25, TOP50 and smaller scaled maps are changed or supplemented accordingly.

The status and progress of the work is visualized internally on a digital progress board, displayed on large screens on the department floor and available on the intranet, on which the above-mentioned steps of the process are schematically put behind each other as column headers, while cards representing each local historical society are running stepwise through the columns and show at what stage the (data of the) society is. Separate from this project and process, in a general 5% sample check on all TOP10NL data the quality of all features is measured, which for toponymic data is mainly based on the maps sent by the societies and the forms filled in by the topographers.

Recent developments

The new process started in June 2017. By the end of January 2018, all local historical societies necessary to cover all areas of the Netherlands were approached with the request to cooperate. As of July 2018, nearly 75% of these societies returned their maps or agreed to cooperate, received a map and are still busy working on it. With some delay due to capacity issues, in early 2018 the processing of the received information was started.

Still, more than 25% of the approached historical societies does not want to cooperate or does not respond to the request. If possible, village associations are approached instead, and some individual volunteers have declared their willingness to do field work in other areas of their home province where no historical society is available. Nevertheless, it is inevitable that there will be some areas where no update according to this process is possible. During the project, internal discussions arose because of the large differences in the number of 'missing' names added by the societies, particularly building names and area names, influencing the consistent coverage of names in the BRT over the country. This underlines the desirability of an additional source for supplementing the names in areas with a 'less enthusiastic' society. Moreover, many societies do not venture to define the approximate boundaries of the areas for area names, which are necessary to verify if the text size of existing names on the map is correct.

Despite the great success of cooperating with local historical societies to update toponymic data in the BRT, their contributions are thus not sufficient to update the names all over the Netherlands. A VGI application open to all users would possibly meet the need for supplementary names, in order to retain a consistent nationwide coverage of names in the BRT, as well as for the approximate boundaries of areas in case of area names. This could be anticipated and therefore, the additional use of a VGI application in the future was already included in the project proposal to set up the process for updating toponymic data in cooperation with historical societies.

3.7 Consequences for the BRT workflow

The project with local historical societies shows the importance of the presence of toponymic expertise within Kadaster. The experience of long-term employees appeared highly valuable, not least to assess the contributions of the historical societies.

As with all features and attribute information in TOP10NL that are not present on aerial images and need to be collected by using external data sources, it works best to update toponymic data in a separate maintenance process. This does not only apply to the current project, but also to a structural yearly maintenance process. In order to secure a complete update of all toponymic data across the Netherlands and have a fairly consistent coverage of names nationwide, using existing data sources, contributions from local historical societies and user reports from the user feedback system could perhaps be supplemented with contributions from a VGI application for the targeted collection of toponymic data in general and a correct demarcation of geographical area boundaries in particular. Such an application should be open to all users and also gives people with knowledge on local geographical names but not involved in a local historical society, the opportunity to contribute. This would make sure Kadaster can make optimal use of all available knowledge in society, in addition to official data sources such as the BAG.

There are several possibilities to process the results of the VGI application in the BRT. One option is to integrate them in the yearly update process with local historical societies, by letting the societies assess and confirm the names and boundaries of areas. This can also serve as an additional quality check. Another option is to process the results of the VGI application separately, as soon as possible when they come in, but this bears the risk that historical societies will comment on them in the following year's update anyway and newly added names and areas already have to be adjusted again. A third variant is a combination of the previous two, to process the results separately and as soon as possible, but to ask and give the local historical societies the opportunity to assess and confirm the proposed change.

An internal expert group for the processing of toponymic data is indispensable for maintaining data quality and for the necessary knowledge and insight in the consistency of the toponymic data and the contributions to update them. The rules and regulations for the registration of geographical names are an important tool for this. They have to be in accordance with the legislation and agreed standards,

In this context, the national standardization of geographical names in the Netherlands would be helpful to synchronize the policy for the BRT with other key registers and governmental data sets. It would improve the consistency in the registration of names regarding orthography and geometrical delineation. Moreover, it would have the advantage that it would stimulate cooperation amongst the governmental agencies involved in the registration and use of names, which would make it possible to share more knowledge and experience on this subject.

3.8 Evaluation of crowdsourced toponymic data

Rules and regulations for the registration of toponymic data can be used to evaluate crowdsourced toponymic data in general and more specifically, to evaluate the data resulting from the pilot with the VGI application in the context of this research, as described in Chapter 4. In the pilot, volunteers are requested to draw polygons and determine the boundaries for geographical area features present in

TOP10NL, but also for new or missing geographical area features. Besides, as a special request volunteers are asked to draw polygons and indicate the approximate boundaries for at least 3 regions out of a selection of 15 larger regions in the Netherlands. The underlying ideas for these questions are described in Section 4.1.

Data quality elements

An important part of the rules and regulations for the registration of toponymic data is a quality assessment of the data, based on the general quality indicators for spatial data. There is a wide consensus in geo-information science about the aspects that indicate the quality of geographical data. These are laid down in a standard of the International Organization for Standardization, ISO standard 19157. This document defines six main data quality elements to describe the aspects of geographical data quality. The elements and their definitions according to the text of the standard are (ISO 2013):

- Completeness: the presence or absence of features, attributes and relationships. This can occur as omission, absent data, or as commission, excess data.
- Logical consistency: the degree of adherence to logical rules of data structure, attribution and relationships. This can be specified as adherence to a conceptual schema, value domains, the physical structure of the data set, or its topological characteristics.
- Positional accuracy: the accuracy of the position of features within a spatial reference system.
- Thematic accuracy: the accuracy of quantitative attributes and the correctness of non-quantitative attributes and of the classifications of features and their relationships.
- Temporal quality: the quality of the temporal attributes and temporal relationships of features.
- Usability: this element has no fixed definition, as it is based on user requirements, for which all other quality elements may be used. In case it is based on user requirements that cannot be described by the aforementioned quality elements, it describes a data set's suitability for a particular application or conformance to a set of requirements.

The first five aspects are described as internal quality measures, as they describe the quality of the data itself. The sixth aspect, usability, is termed as an external quality measure. This aspect can only be defined in the context of known user requirements and can relate to the other five quality elements. (Fonte et al. 2017).

Evaluation criteria

In order to be able to apply these quality elements on crowdsourced toponymic data collected with the VGI application described in Chapter 4, for each data quality element evaluation criteria had to be determined. This has been done before the application was built and the pilot started, to prevent the criteria from being influenced by the results. The criteria are formulated as questions and classified according to quality element, based on general experiences with data quality and the existing rules and regulations for toponymic data and BRT data.

Completeness:

- Has all the requested information been made available by the volunteers?
- Is the required names density reached, are all existing names provided?
- Are names in all parts of the Netherlands provided?

Logical consistency:

- Are the polygons drawn in a consistent manner?
- Are there any illogical overlaps of different areas?

Positional accuracy:

- Are polygons drawn for the approximate correct area?

Thematic accuracy:

- Is the spelling of names correct, in accordance with the spelling rules and with the official names?
- Have the feature types been correctly designated?

Temporal quality:

- Are the area names still in use?
- Does the area as such still exist (e.g. no field names disappeared under newly built neighborhoods)?

In addition to the data quality elements, a number of targets have been set for the pilot to determine if the test results are useful. These targets are:

- At least 10 different users should have drawn polygons
- In total, at least 20 different polygons should have been drawn
- There should be at least 3 large regions for which at least 3 polygons each have been drawn

All these evaluation criteria and targets are used to assess the usability of the data for processing and registration in the BRT. The assessment of the data is described in Chapter 5.

4. A VGI application for toponymic BRT data

4.1 Requirements for the VGI application

From the previous chapters, it follows that it is worthwhile to investigate the possibility to crowdsource toponymic data by involving the general public in the update process of the BRT. Therefore, the main part of this research consists of a pilot project in which toponymic data is collected with the help of individual volunteers. To be able to test this, a VGI application was built.

Before building the application itself however, besides the evaluation criteria described in Section 3.8 there had to be clarity about the requirements for the application. These can be divided into two categories, which can be framed as external and internal requirements. The internal requirements relate to the application itself: design, contents, interface, tooling, etc. External requirements are about the context of the application and the pilot and can be described by answering the Five W questions: who, what, where, when and why? (Wikipedia 2018f). They provide the necessary basis for working out the internal conditions and were to be determined first.

4.1.1 External requirements

The 'who' can be seen in two ways. With regard to whom the application is intended for, it is the crowd that should use the application. Given the fact that there is only a limited test period, it is difficult to really ensure a large-scale participation of all interested and knowledgeable people in collecting toponymic data. The steps taken to, nevertheless, involve as many people from diverse backgrounds and locations as possible are described in Section 4.3. The other 'who' of course are the people who enable the application and the organization of the test. Those are the author of this research and several Kadaster colleagues who have helped with building the application and advertising the pilot. The building process is described in Section 4.2.

The application itself is the 'what' that is tested. But more specifically, the question is what kind of toponymic data is suitable for testing. Because it is very hard to predict the number of volunteers and contributions, it seemed better to test the possibility of crowdsourcing on a selection of the names rather than to include all names present in TOP10NL in the application. This way, the contributions are concentrated on a specific set of names and the subsequent results are more relevant for that category. On the other hand, it is not entirely certain whether the outcome will still be valid for other names categories as well.

Then the question becomes, which names category in the BRT would be most suitable for crowdsourcing. For some categories, such as administrative areas and most street names and populated place names, an official source exists and thus crowdsourcing has little or no added value. Most functional area names and part of the water and building names can be found with existing data sources. Toponymic data for which it is most difficult to find an existing data source, are local water names, farm and residential building names, dispersed settlements and geographical area names. Of these, the collection of area names and dispersed settlements has an extra dimension, as the boundaries of the areas are also needed. Moreover, area names have the advantage over water names that they exist in large densities throughout the country, while they have the advantage over building names that area names are part of the public space. The latter may result in a higher motivation for volunteers to contribute, as people feel connected to these areas, while most building names are

chosen by their owners and are primarily of personal value to themselves. This has led to choosing area names, including dispersed settlements, as the names category to test crowdsourcing for with the VGI application.

Also for the 'where', there are two ways to look at it. One has to do with the area for which the VGI application is tested and the toponymic data are selected. The TOP10NL database contains the topography of the whole of the Netherlands and thus the Netherlands is the largest area for which the application can be tested. It is possible to test only on a smaller selected area. This has the advantage that contributions are concentrated on a smaller area and just as applies to a selection by category, it will be easier to compare them with each other and draw relevant conclusions. A disadvantage however is that there must be enough participants from this selected area who are able to make relevant contributions. Since the intention is to test the application on the general public and all communication channels of Kadaster available to announce the application have a national coverage, it was more obvious to make an application for the Netherlands as a whole and let volunteers from all over the country test it, with all available data for the selected categories present.

A second 'where' relates to the location of the application itself: the platform used to develop it. This already implies a preference to build an application instead of asking volunteers to use an existing VGI platform and collect the data from there. Using existing platforms, such as OpenStreetMap, GeoNames or Wikimapia, has a huge disadvantage in that it is very difficult to influence the process and structure of the data. To mention some of the practical issues: it is not possible to enforce the providing of certain attributes; provided information can immediately be edited by others and may already be deleted before the end of the pilot; and it is more complicated for new volunteers to get familiar with the platform and to know how to use it, which may lead to a lower participation in the pilot. In short, using existing VGI platforms means being only one of many users of the data, whereas a self-built and managed application allows testing the use of VGI under the preferred and necessary conditions.

There are several platforms available to create a VGI application. Some of them are open source and free to use, such as Ushahidi, which was developed to support disaster management (Ushahidi 2018). By creating a platform which allows aid organizations to quickly and easily setup a VGI application, local volunteers can as quickly be called in to help gather the necessary data. It is free to use, but the available options and the possibilities to customize the application are rather limited. This may have to do with the fact that Ushahidi was developed specifically to create applications for crisis mapping, rather than as a generic VGI application platform. Most other open source platforms are designed in such a way that they do not even offer the possibility to set up an application for other purposes than the specific data or collection category for which the platform was intended.

A more advanced development tool is provided by Esri, one of the main commercial developers in GIS software. Linked to its ArcGIS GIS software package, it offers a web application development platform called ArcGIS Online (Esri 2018b). It allows taking layers created or available in ArcGIS and using them directly as a basis for a new web application. Subsequently, the resulting contributions of the web application can be easily loaded into the ArcGIS Desktop software and used for analyses and visualizations. Kadaster has many licenses for ArcGIS and uses it as the main software to maintain the BRT databases. In the past, experiences have already been gained with the use of ArcGIS Online as

well. On the basis of these positive experiences, and because it is a more generic tool, it was decided to use ArcGIS Online as the platform for the VGI application.

The time frame to perform the test with the application answers the 'when' question. The application as part of this research was built in January 2015 and the subsequent pilot period lasted from mid-February to the end of March 2015.

The final question, 'why' developing a VGI application to collect toponymic data, has already been dealt with in detail in the previous chapters of this thesis. Nevertheless, the question remains what the exact purpose of the application would be. In other words, what is the specific assignment volunteers are asked to perform within the application? The choice had already been made to use geographical area names. An additional aspect in collecting them is that the boundaries of the areas concerned have to be collected as well. Geographical area features in TOP10NL are only available as point features and there is a need to know the associated boundaries of these areas to be able to transform the points into polygon features. In addition, it would be valuable to be able to obtain new area names with their associated area boundaries. The assignment description to potential volunteers therefore has to be general: please indicate as many boundaries for area names as you know, either by choosing an existing point feature and drawing a polygon for the area concerned, or by adding a new area name and drawing a polygon for it. To be able to compare polygons drawn by different users for the same area and find out if it is possible to determine an 'average' area boundary based on all the contributions, a more specific additional question to volunteers is to draw polygons for at least 3 large regions out of a group of 15 selected and well-known large regions in the Netherlands.

The collection of names and of area boundaries are in fact two aspects to test the use of VGI, although both are closely related. The usability of VGI for each aspect can be assessed individually, as they do not affect each other. If the question to volunteers would be only to collect names, they still had to indicate the location of the name, and if the question would be only to indicate the boundary, users inevitably had to identify the area with a name as well.

4.1.2 Internal requirements

Internal requirements can be categorized according to their importance using the MoSCoW method, which is very popular in the world of software development (Wikipedia 2018g). The method distinguishes four main priorities:

- Must have
- Should have
- Could have or nice to have
- Won't have

Must have requirements are indispensable and must be part of the product. Should have requirements are very important, but may be delivered at a later stage or in another way without having an unworkable product. Could or nice to have requirements are a useful addition that improve the product, but are only included if there are enough resources and time available. Finally, Won't have requirements were mentioned during the development of the product and have been agreed not to include in the product, but may be reconsidered at a later moment.

There are several aspects of the VGI application for which requirements were listed. These aspects are, in random order:

- Visual requirements
- Editing requirements
- Tooling requirements
- Interface requirements
- Processing requirements

The requirements themselves can be based on best practices known from earlier research and other applications (Capineri et al. 2016; See et al. 2017; Sylla et al. 2018). For the latter, the functionalities of the existing OpenStreetMap editors can be an example, as well as the former Google Map Maker, which existed between 2008 and 2017 and served as a VGI platform to help edit and improve the quality of Google Maps.

An overview of the requirements per aspect according to the MoSCoW method priorities is provided in Table 1.

Table 1: VGI application requirements

Requirements	Must have	Should have	Nice to have	Won't have
Visual	• Background map • Aerial images • Geographical areas as point features • Large regions as point features	• Background map based on BRT data • All layers of recent date • Introductory text with explanation	• User guides for application	
Editing	• Editable polygon feature layer			
Tooling	• Drawing tool • Mandatory input fields: area type, area name and user's e-mail address		• Spray-can paintbrush tool • Endorse option • Name proposal option • Comments or file adding option	
Interface	• Desktop PC compatibility • Tablet accessibility • Separate drawing environment, with drawn polygons invisible • Separate results environment	• Tablet and smart phone compatibility		
Processing	• App to desktop software interoperability		• Automated GIS analyses	

Regarding the visual requirements of the application, 'must haves' are:

- A background map, necessary for orientation
- A background layer of aerial images, necessary both for orientation and to determine the location of the boundaries when drawing polygons

- A point feature layer with the geographical areas and dispersed settlements of TOP10NL, necessary to know for which objects polygon features are desired.
- Another point feature layer with the names of the following 15 well-known large regions: Hogeland, Gaasterland, Hondsrug, Salland, Twente, Veluwe, Betuwe, Achterhoek, Utrechtse Heuvelrug, West-Friesland, Groene Hart, Kempen, Meierij, Peel, Heuvelland (in southern Limburg). These are necessary to be able to test if it is possible to calculate an average area boundary out of multiple polygons.

The background map should be based on BRT data, as the application is meant to collect data for the BRT. The background map, the aerial images and the point feature layer with geographical names should be of a recent date, to be as close as possible to the current situation known and familiar to the volunteers. Another 'should have' requirement is a short introductory text with an explanation of the application, the pilot research and the request to draw as many polygons for existing or new geographical area names as possible, as well as to draw polygons for at least 3 large regions out of the selected 15 large regions visible in the application. 'Nice to have' is a user guide for every device interface. For most users, the latter would be superfluous if the application can be used intuitively.

With regard to the editing requirements, the 'must have' is an editable polygon feature layer of geographical areas in which volunteers can draw a polygon for all areas they want to indicate the boundaries for. This layer must also contain attribute fields for feature type, feature name, and the user's e-mail address. Without this layer, editing in the application and thus the generation of resulting data is completely impossible.

'Must have' tooling includes:
- A drawing tool, necessary to be able to add polygons to the polygon feature layer
- Mandatory input fields to add the feature type, feature name and user's e-mail address when completing the drawing of a polygon. This attribute information is necessary for proper processing of the data.

'Nice to have' tooling includes:
- A spray-can paintbrush tool, which would make it possible to draw or indicate fuzzy boundaries for polygons. The current TOP10NL database settings however, do not provide the opportunity to register polygons with fuzzy drawn boundaries, and there are alternative options to indicate the fuzzy character of the polygon boundaries with an additional attribute field, which does comply with the database structure.
- An option to endorse an existing polygon, making it superfluous for users to draw a new polygon if they want to indicate the correct boundaries of an area.
- An option to propose a different name for an existing polygon, while endorsing the polygon's geometry, which has the same advantage as the previous requirement.
- An option to add comments or a file with background information on the drawn area or to add a link to an external source containing (information on) the area's boundaries. This would make it possible to substantiate a contribution and provide information that can be useful for its assessment.

Regarding the interface of the application, the 'must haves' are:

- Desktop PC compatibility and tablet accessibility, as these are the most obvious devices to make contributions.
- A separate drawing environment and a results environment, both visible to users, where in the former existing polygons - those drawn by other users - are invisible, to avoid influencing when drawing new polygons. In the latter the boundary, feature type and feature name should be visible; for privacy reasons, the user's e-mail address should remain invisible.

Specific tablet and smart phone compatibility are 'nice to have'. As a substantial screen size would improve the visibility of the background layers and thus the possibilities to work accurately, users should be advised to use a desktop PC or laptop.

For processing the test data, a 'must have' is interoperability between the application and the regular ArcGIS software used in the BRT maintenance processes. A particular concern is the possibility to easily import polygons drawn by volunteers into ArcGIS in order to perform GIS analyses, automated validation steps, quality control and if approved, to add them to the TOP10NL database. Automated GIS analyses would be 'nice to have' for processing, e.g. an automated method to get a single fuzzy boundary out of multiple drawn polygons for the same area. This can however also be done manually.

4.2 Building the VGI application

4.2.1 Introduction

After having drawn up the requirements for the VGI application, the next step was to build the application itself. Based on consideration of the various platforms and tools available, this has been done on the ArcGIS Online platform. As stated earlier, Kadaster uses ArcGIS as the main software package in the maintenance process of the BRT and has many licenses for the desktop versions of the software. As a result of this, it can also use many licenses for ArcGIS Online. ArcGIS is one of the leading GIS software packages in the world, developed by the American company Esri. It provides from plain simple to very advanced tooling to edit, analyze and visualize geo-information and maps. ArcGIS also contains several extensions aimed at specific customer or usage requirements. The Model Builder environment and support of the Python programming language allows for nearly unlimited customization of analyses and visualizations (Esri 2018a). Within Kadaster, the fairly complex automated generalization process for all small-scaled map products of the BRT, from 1:50.000 (TOP50) up to 1:1.000.000 (TOP1000), has been developed with the help of ArcGIS Model Builder and is currently rewritten using Python scripting.

ArcGIS Online is an online platform that is linked to the ArcGIS desktop software. It offers the possibility to share geographical data as a user, separately within a group or with the entire internet community. Esri itself also creates composite data and map products and publishes them on ArcGIS Online. Subsequently, all published data can be searched and directly loaded in the ArcGIS desktop software. Since many users want to visualize and publish their data on the web, ArcGIS Online provides users the option to build web maps and web applications. This environment of the platform has been used to create the VGI application to test the crowdsourcing of toponymic data in the BRT.

The application has been coined *Vlakbijnamen*, a Dutch wordplay meaning both 'nearby names' (if read as *vlakbij-namen*) and 'polygon to names' (if read as *vlak bij namen*).

The built-up of the VGI application followed three main steps:

- Creating an editable layer
- Creating and setting up web maps
- Creating and setting up web mapping applications

The original application is currently not accessible anymore because the background layers used no longer exist. However, a remake of the *Vlakbijnamen* application has been built with more or less comparable layers, tools and visualization settings, with the exception of making the polygons visible in the drawing environment. The remake application can be found under the following URL: http://kadata.maps.arcgis.com/apps/View/index.html?appid=93bea1ee736c43e09963af8b82fcb5b3

4.2.2 Creating an editable layer

The first step has to be performed with the ArcGIS desktop software. The editable layer in this case is the polygon feature layer for the drawing of geographical areas. On a local network drive a file-based geodatabase with a polygon feature layer has been created. This feature layer has been attributed with the following attribute fields:

- OBJECTID: a standard attribute to give each feature a unique identifier
- Type_gebied: to indicate the type of geographical area drawn
- Naam_gebied: to indicate the name of the geographical area
- Emailadres: to let the contributor provide his or her e-mail address
- Opmerkingen: to give the contributor the opportunity to add remarks to the feature

For the attribute Type_gebied coded values are programmed, with domain values corresponding to a selection of the existing geographical area type domain values of TOP10NL. These are the types to be drawn by the volunteers. The selected area types are:

- *Bosgebied* (forest area)
- *Buurtschap* (dispersed settlement)
- *Duingebied* (dune area)
- *Heidegebied* (heathland area)
- *Streek, veld* (region, field)
- *Overig* (other)

Only these programmed domain values can be assigned to the attribute, by means of choosing one of them from a pull-down list. The attributes Naam_gebied, Emailadres and Opmerkingen are free text fields, meaning users can freely provide a text for the attribute, e.g. an area name, an e-mail address or a remark.

After the preparation of the feature layer was completed, the layer could be directly uploaded from ArcGIS to the personal user environment of the administrator in ArcGIS Online. Upon uploading to ArcGIS Online, the following attribute fields are added to the feature layer:

- CreationDate: shows the date of creation of the feature
- Creator: shows the login name of the contributor, in case of a registered ArcGIS Online user
- EditDate: in case the feature was edited after its creation, this attribute shows the date of the last edit
- Editor: shows the login name of the editor, in case of a registered ArcGIS Online user

4.2.3 Creating and setting up web maps

Now that the feature layer is available as a hosted file in ArcGIS Online, as a second step a web map could be created and composed. The web map contains the layers that are visible in the application and their visualization settings. For this VGI application, in fact two web maps had to be made, to fulfill the interface requirement that users are not influenced through the polygons already drawn by other users. Both web maps contain the same layers, but with different visualization settings.

The following layers are visible in the web maps:

- *Gebiedsvlak*
- *Groot gebiedspunt*
- *Gebiedspunt*, divided in twelve partial layers

The editable feature layer is called *Gebiedsvlak* (Area polygons), with reference to the TOP10NL feature layer *geografisch gebiedsvlak* (geographical area polygons). It contains the attributes as described in Section 4.2.2. Additionally, the option was enabled to add a file to the polygon as appendix. The existing geographical area point features from TOP10NL were to import as the layer *Gebiedspunt* (point areas) with reference to the TOP10NL feature layer *geografisch gebiedspunt* (geographical area points). However, ArcGIS Online allows only a limited number of features in one layer. Since there are more than 10,000 geographical area features, the layer had to be cut into twelve parts, named *Gebiedspunt*, *Gebiedspunt2* etc. to *Gebiedspunt12*. The *Gebiedspunt* layers also include dispersed settlements, which were still part of the geographical area feature class in TOP10NL, at the time of creation in 2015. Polder names were left out of the selection, as they can be drawn based on the location of dikes. Information from volunteers therefore, has no added value for those features.

The separate layer *Groot gebiedspunt* (large area points) contains point features for 15 large regions across the Netherlands. These are meant to let multiple users draw polygons of the same area and investigate if it is possible to compare the boundaries and distract a single polygon with an average boundary from them.

The web map has two background layers:

- BRT Background map (*BRT Achtergrondkaart*)
- Background aerial images

Both background layers are provided by PDOK (*Publieke Dienstverlening op de Kaart*, Public Services on the Map), the national web portal for governmental geographical information in the Netherlands (PDOK 2018b).

The BRT Background map is designed for use as a background layer in web maps and consists of topographic visualizations on 15 zoom levels, level 0 to 14. It contains data from the BRT, supplemented with street names from the BAG that are visualized over TOP10NL road segments. Since the BAG itself does not contain the geometry data for street names, the location of the names is based on the road lines of the National Roads Database (*Nationaal Wegenbestand*) of Rijkswaterstaat. Since June 2018 a large part of these street names is included in TOP10NL and the BRT Background map is truly based on BRT data only.

The aerial images in the other background layer are derived from the *Landelijke Voorziening Beeldmateriaal* (National Facility for Imagery), a national database that contains aerial imagery and street view images. The database is financed and used by several governmental parties in the Netherlands: national government and governmental agencies, provinces, water boards, Gasunie and a very limited number of municipalities. Every year, two sets of aerial images are made of the entire country, one from February to April and one in summer. The first set is provided with 10 cm accuracy, as stereo images and orthophoto mosaics, and used as a basis for the maintenance of the BRT. These orthophotos are also used in the background layer. The second set has an accuracy of 25 cm, provided as stereo, ortho and infrared images, and is mainly used for the recognition and monitoring of vegetation and river courses.

Regarding the visualization settings of the layers in the web map, on small scales – when the entire country or a large part of it is on screen – only the BRT Background map and the 15 large area points are visible. When zooming in to larger scale levels, the aerial images become the main background layer with the Background map still lightly visible through them due to transparency settings. This background has been selected in order to easily draw polygons. Aerial images directly show all real-world objects visible from the air and due to the popularity of aerial image layers in existing applications like Google Maps and Bing Maps, many people are familiar with them. The combination of aerial images and a map as a background should make the real world better recognizable and the drawing of polygons easier than it would be with only a map as a background.

On these higher zoom levels, the more than 10,000 geographical area points from TOP10NL also become visible over the background layers. These point features are visualized with different colors for each area type, corresponding as far as possible to the usual color scheme of a topographic map: forest areas are green, dune areas yellow, heathland areas purple, dispersed settlements orange and field names blue. The 15 large area points representing region names are visualized with a larger red point on a pin.

Polygon features are visualized according to the same color scheme, but only polygons drawn by the user himself in the very same session – from opening to closing or clicking away of the application – become and remain visible in the main *Vlakbijnamen* web map. They are visible on all zoom levels. Polygons drawn earlier or by other users are visible in the second, separate *Vlakbijnamen overzicht* (Vlakbijnamen overview) web map, which for all other layers uses the same visualization as the main web map.

Thanks to the interoperability between ArcGIS Online and ArcGIS Desktop, the layers of the web map can be loaded and visualized directly in the desktop software (Figure 9).

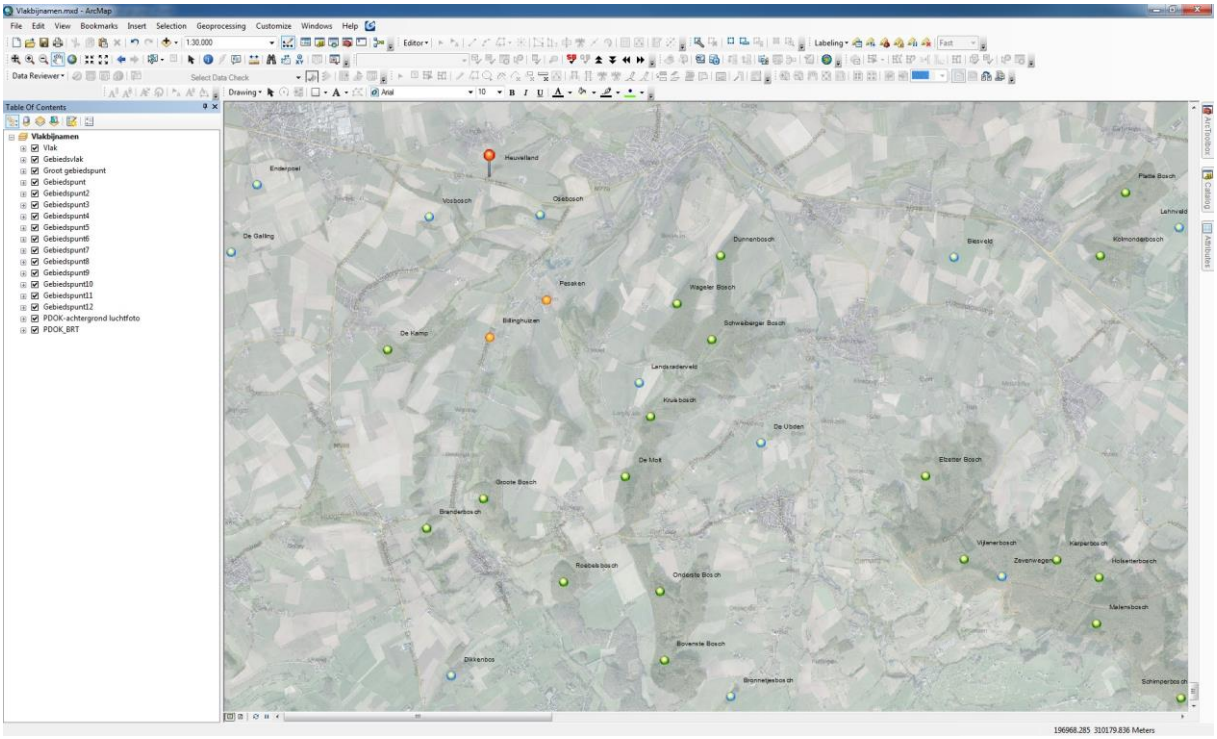


Figure 9. Vlakbijnamen web map as visualized in ArcGIS Desktop software. Through a direct link in ArcGIS Online all web maps can be loaded and opened in ArcGIS Desktop software.

4.2.4 Creating and setting up web mapping applications

Based on a web map, a web mapping application can be created. Web maps can be published on the internet and made visible to others, but only contain a standard interface to view the layers with their possible attribute tables. If a customized interface or in this case additional tooling is desired, one needs to setup a web mapping application.

A web mapping application always contains a menu for the title and the tooling of the application. The layout of the menu can be customized as a small frame in the upper left part of the map or docked in the upper left corner of the screen, or as a title bar filling the top of the screen with a tool sidebar on the left of the screen. The color scheme of the menu, the text of the title and possible subtitle of the application, and the available tools can be set or chosen as desired. When clicking on a tool, in all options the tool's menu pops up in the upper right part of the map.

In case of the *Vlakbijnamen* application, the title features prominently in the application menu. While chosen for the upper left option as a frame in the map, the menu has a green background with white text and icons. If started, the application opens the web map on a medium zoom level with Zwolle in the center. The following tools are present, from left to right in the menu frame:

- + and – buttons to zoom in and out in the map.
- Home button (house icon) to return the map view to the initial medium zoom level centered on Zwolle.
- Legend button to activate a pop-up window in the upper right with the legend. The legend adapts to the map view, only showing layers that are visible in the present zoom level.
- Locate button to pan the map to the location of the user, if available and allowed by the user.

- Edit button to activate a pop-up window in the upper right, where a user can click on the Polygon layer and start drawing a polygon.
- Details button to activate a pop-up window in the upper right, with a short explanation of the application and the request to draw polygons to the names.
- Share button to activate a pop-up window in the upper right, with options to share the map on social media, via e-mail or copy the URL of the map to the computer's clipboard.

The menu also contains a search bar to find a location by entering its name. The search engine invokes the Esri Netherlands BAG geocoder, which contains the coordinates of addresses, street names and populated place names in the Netherlands. Although the name of the geocoder suggests it is merely based on data from the BAG, apparently it also contains names of hamlets and dispersed settlements only present in the BRT.

Optional buttons and tools not chosen to visualize in the menu, are a scale bar, a measure tool to measure distances, a tool to add base maps, a button to activate an overview map, a tool to toggle the visibility of map layers, and a print tool to create a print layout of the map. This was done to limit the number of buttons and tools in the menu to the ones necessary to explain what the application and the pilot is about, and to draw the polygons. The share button was added to allow for the generation of additional publicity for the pilot.

The options provided in the web mapping application configuration wizard did not include the possibility to endorse a polygon drawn by other users, or to propose a different name. These nice to have requirements therefore could not be realized. It is possible to allow users to edit each other's contributions; however, it is not possible to see the edit history in that case. In order to ensure that all original contributions remain consultable, it was decided not to provide this option and instead ask people to draw polygons regardless of whether a polygon has already been drawn for the area.

To explain the meaning of the application, at startup users see the following message, which can also be activated with the Details button in the menu:

> *In Vlakbijnamen vind je verspreid over Nederland meer dan 10.000 gebiedsnamen uit de topografische bestanden van het Kadaster. De locaties zijn helaas alleen als punt bekend. Welk gebied hoort er bij de namen en waar ligt de grens ongeveer? Help het antwoord te vinden door een vlak bij de namen te tekenen.*
>
> *Met de knoppen linksboven verplaats je het kaartbeeld naar een gewenst punt. Klik op de knop Bewerken en rechtsboven op "vlak" en je kunt beginnen met tekenen.*
>
> *Teken ook een vlak in voor zoveel mogelijk 'grote streken' (zie knop Legenda). Zo kunnen we samen bepalen welk gebied er bij deze namen hoort.*
>
> *Alle ingetekende vlakken kun je hier bekijken. Meer info over het onderzoek vind je hier.*
>
> *Alvast bedankt voor je bijdrage.*

The text translates to English as:

> In *Vlakbijnamen* you will find more than 10,000 area names across the Netherlands from the topographic databases of Kadaster. Unfortunately, the locations are only known as a point. Which area belongs to the names and where are the approximate boundaries? Help to find the answer by drawing a polygon to the names.
>
> Use the top left buttons to move the map view to a desired point. Click on the Edit button and in the top right on "polygon" and you can start drawing.
>
> Also draw a polygon for as many 'large regions' as possible (see Legend button). This way, we can determine together which area belongs to these names.
>
> You can view all the drawn polygons here [link to the *Vlakbijnamen overzicht* application]. More information about the research can be found here [link to an article on the Kadaster website].
>
> Thanks in advance for your contribution.

If a user zooms in on the map to a level where aerial images become visible, several area point features labeled with their name appear. Clicking on a point feature opens a pop-up window showing the attribute fields Area type, Dutch name and Frisian name. The latter attribute is only used in the Frisian language area (Figure 10). When a user follows the instructions as described in the aforementioned explanatory text and has drawn a polygon, a window pops up in which the user has to fill in an area type, the name of the area and an e-mail address. Moreover, a field to add remarks and an option to upload a file to the polygon is provided. When finished, users can go to the *Vlakbijnamen overzicht* application to see the newly created polygon with all other drawn polygons on the map.

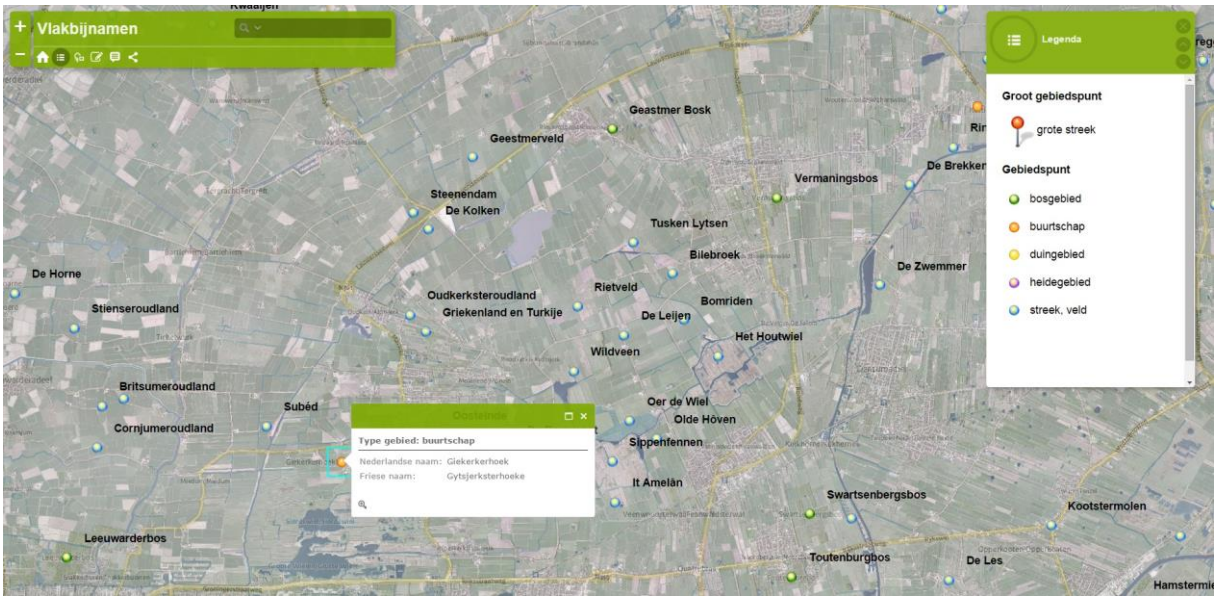


Figure 10. Screenshot of the Vlakbijnamen application with the menu in the upper left, the legend in the upper right, and a pop-up window in the center showing a point feature's attributes after clicking on the feature.

For the *Vlakbijnamen overzicht* application all the settings are identical, to maintain uniformity in the applications. Only the Edit tool is not available in the menu, since this second application is only meant to give users the opportunity to view their own and each other's contributions. At startup and by clicking on the Details button, the following message appears:

> *Hier vind je een overzicht van alle vlakken die zijn ingetekend in Vlakbijnamen. Zo kun je controleren of een vlak dat je hebt getekend, goed is opgeslagen en of het type gebied en de naam zijn ingevuld. Je kunt ook de vlakken bekijken die andere vrijwilligers hebben getekend.*
>
> *Meer info over het onderzoek vind je hier.*
>
> *Bedankt voor je bijdrage.*
>
> Here you can find an overview of all areas that were drawn in *Vlakbijnamen*. This way you can check whether a polygon you have been drawn has been saved correctly and if the area type and the name have been provided. You can also look at the polygons drawn by other volunteers.
>
> More information about the research can be found here [link to an article on the Kadaster website].
>
> Thank you for your contribution.

By default, the area type and the name of the drawn polygons are labelled in *Vlakbijnamen overzicht*, and these are also the only attributes that become visible when clicking on a polygon (Figure 11). Other attribute information, such as remarks, e-mail addresses and possible files added as appendix to the polygons, are only visible to the administrator of the application.

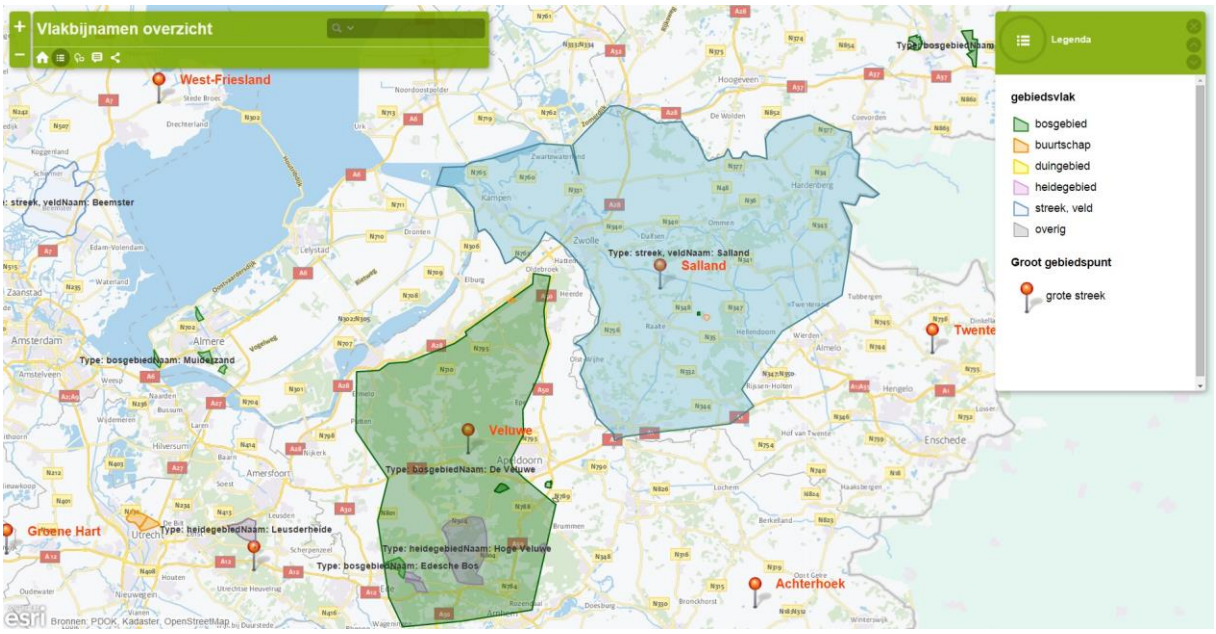


Figure 11. Screenshot of the Vlakbijnamen overzicht application, with polygons drawn by volunteers for several areas.

In the personal user environment of the administrator in ArcGIS Online, the use of the web mapping applications can be monitored, settings can be adjusted at any time and all data can be live consulted and viewed in the ArcGIS desktop software. Obviously, it is also possible to export and save the data as a backup.

Although the entire process of building the applications takes a considerable amount of time, it is fairly easy to do with some knowledge of ArcGIS and insight into the required settings. The wizards of ArcGIS Online are user-friendly and help to make the necessary choices, so that GIS professionals who are not experienced in building web mapping applications can still achieve a nice result.

In addition to VGI applications for the editing of data, ArcGIS Online is also suitable for publishing interactive (thematic) maps with a self-designed visualization and layout. With the separate Esri Story Maps environment, maps can be combined with explanatory text and features to facilitate storytelling with maps (Esri 2018c).

4.3 Pilot

After completing the building of the VGI applications, they were published on the internet to make them accessible to all users of the web. The next challenge was to find enough volunteers to use the application in a pilot period. For this purpose, the Communication department of Kadaster became involved.

Kadaster has several communication channels to inform and interact with customers and the general public about its products and activities. The most important one is the Kadaster website, which features news items, information on products and services, information on the agency itself, etc. In addition, the company is active on social media and has a profile on Facebook, an account on Twitter, a YouTube channel and a company profile on LinkedIn. In the Groups section on LinkedIn, there is also a specific group for the BRT, where Kadaster can post messages and users can add comments.

To inform as many people as possible about the pilot with the *Vlakbijnamen* applications and ask them to contribute, Kadaster agreed to post a news article on the website and to refer to it in a Facebook message and a tweet. The news article was posted on Wednesday, 18 February 2015 and marked the start of the pilot period. Messages on Twitter and Facebook followed shortly afterwards. A message on the LinkedIn BRT group posted in the same period, caused a lot of reactions from interested volunteers and led to a lively discussion. These reactions are further discussed in Section 5.2.7. The translation of the text for the various articles and messages can be found in Appendix A to this thesis.

An important announcement in the messages was the fact that the pilot served as part of a larger research into the possibilities of crowdsourcing in the collection and maintenance of toponymic data, and that contributions made through the VGI application would not directly be processed in the data sets of the BRT – the latter in order to manage expectations.

The news article on the Kadaster website was found and copied the next day by *Binnenlands Bestuur* (Domestic Government), a magazine for civil servants and managers in all areas of public government, with news, reports and opinion articles on governmental issues. This may have generated additional attention and contributions (Figure 12).

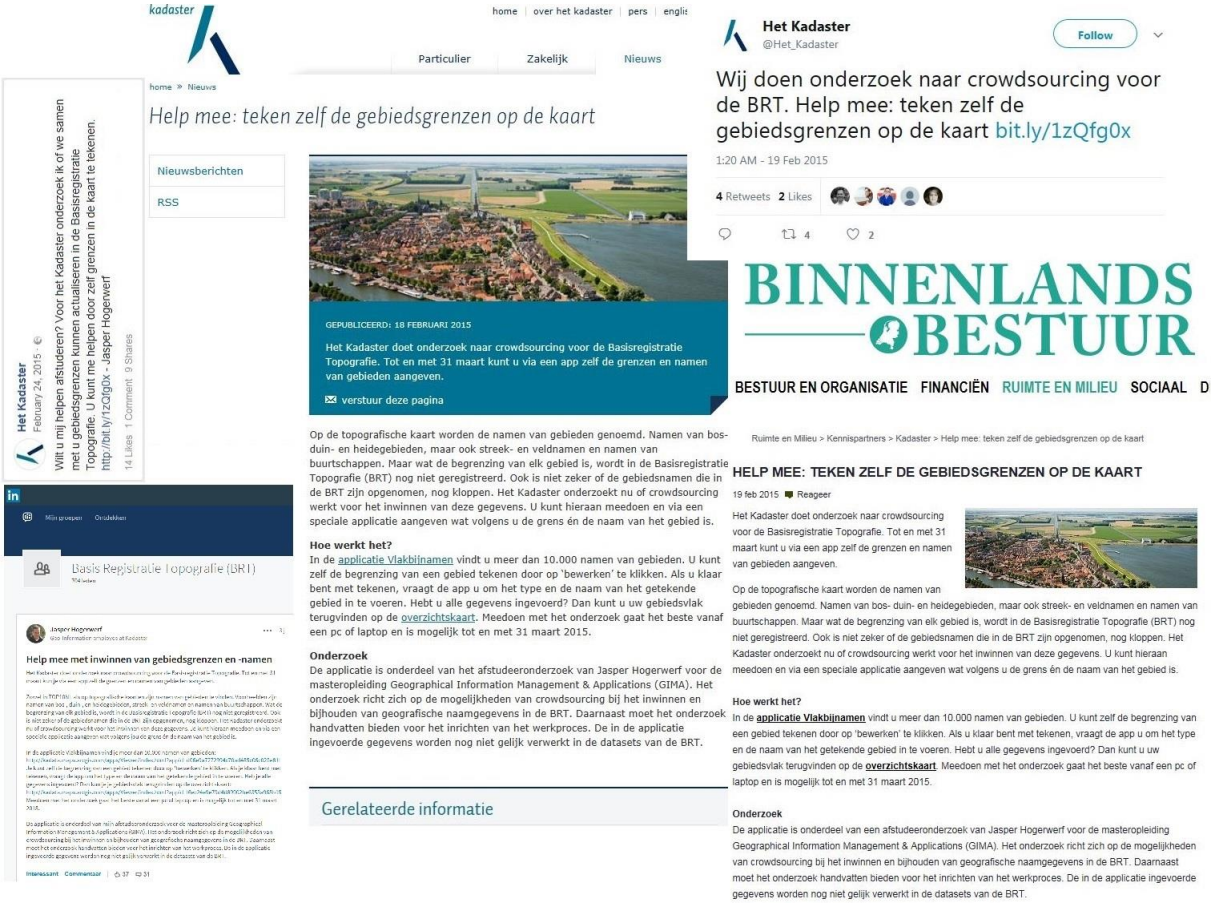


Figure 12. Collage of messages advertising and requesting to cooperate in the test with the Vlakbijnamen applications.

The first polygon was drawn on 19 February 2015. At the end of the same day, a user reported that a setting for the editable polygon feature layer appeared to be wrong: in the *Vlakbijnamen overzicht* application, polygons could still be edited and even removed. The next day, an attempt was made to solve this problem. Unfortunately, the setting in question could not be altered as long as the layer was in use and edits were made to it. A solution was found by creating and adding a new editable polygon feature layer, with the exact same attributes and visualization, to both applications. For this layer, editing a polygon was set to be allowed only by its creator during the same session. The original polygon feature layer remained visible in the applications, but was set as no longer editable, while the new layer was not shown in the legend. This way, nothing changed in the application in terms of appearance. In the evening of 20 February, the problem was solved, without any unwanted edits or deletes of polygons on the two previous days.

The pilot period formally ended on 31 March 2015. No other issues were reported during this period.

5. Evaluation of the results

5.1 Statistics of the pilot

The pilot period to test the VGI application Vlakbijnamen lasted for six weeks. In this period many people read one of the messages, clicked on the link to open the application and quite a few of them really took the opportunity to share their knowledge by drawing one or more polygons. The usage statistics for the polygon layers show a large number of requests in this period.

After the pilot period formally ended, on 5 April 2015 the editable polygon layers of Vlakbijnamen were both opened in ArcGIS Desktop and exported and saved for further analysis of the results.

In total, 398 polygons were drawn during the pilot. This is far more than the target number of 20 set before the pilot started. Thanks to all the attention generated through the various media channels, many people came to know about the pilot, which undoubtedly contributed to this great success. However, not for all polygons the information is completely provided as requested. In 32 cases the name field of the polygon is empty or the name "*test*" or "*foutje*" (mistake) is entered. Only 366 polygons have a geographical name. Of these 366, 18 polygons have no area type, while another 29 do have an area type but no e-mail address. It follows that for 319 polygons the information is complete, which still is a relatively large number (Figure 13).

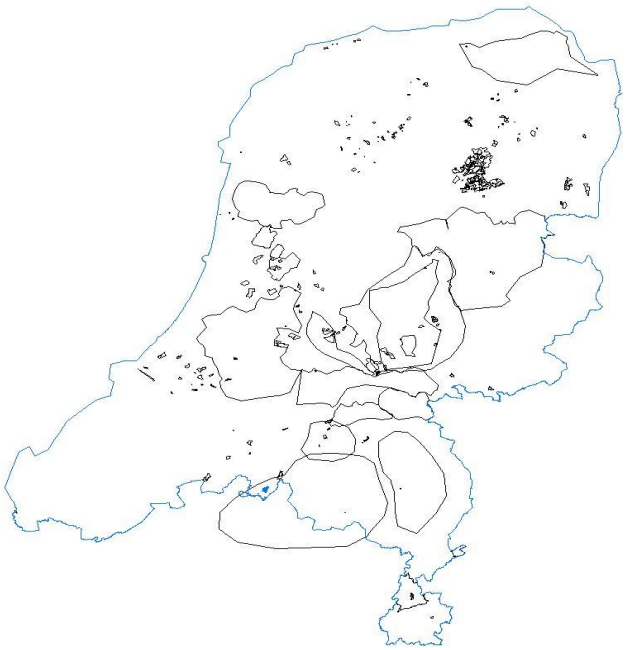


Figure 13. Overview of all polygons drawn during the pilot period in the Vlakbijnamen application.

The number of requests per day on the two editable polygon layers shows that the application was very popular in the first week after the announcements on the Kadaster website and on Twitter. It peaked on 25 February, the day after the message on Facebook was published. In the first half of March the number of requests slowly decreased, to peak again on several days in the second half of March. The last polygon was drawn on 30 March and in the weeks after the formal end of the pilot period, no more polygons were added to the layer (Figure 14).

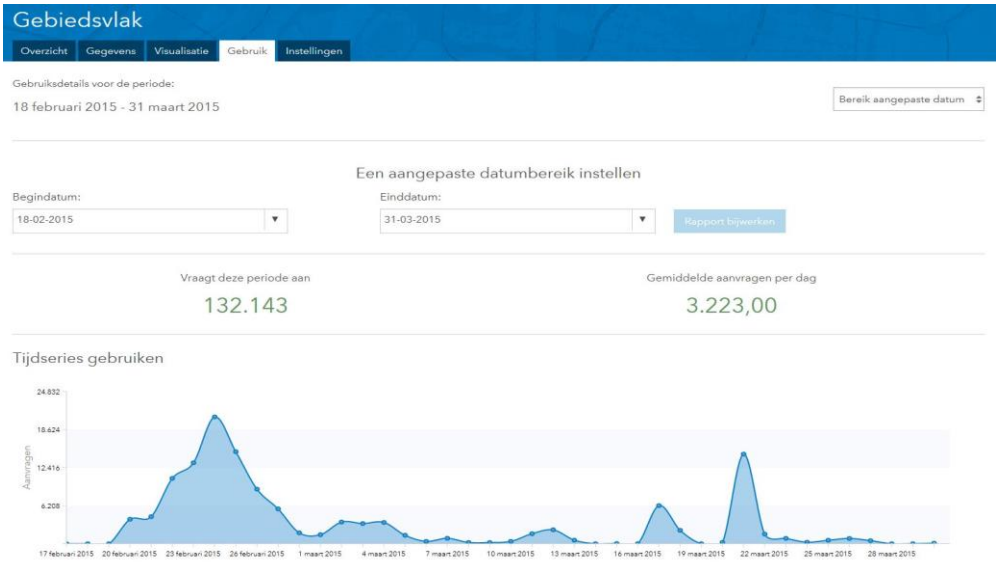


Figure 14. Diagram with the number of requests per day for the second polygon layer in the Vlakbijnamen application during the pilot period. For the first polygon layer the numbers of recorded requests were: 682 on 18 February, 15,885 on 19 February and 4,704 on 20 February.

Based on the aforementioned figures it will not be surprising that the target minimum number of 10 users drawing at least one polygon has been met by far. Not less than 54 different e-mail addresses were added to the polygons. This number may have been higher if all polygons would have had an e-mail address attributed to them as requested.

There is a great difference in the number of polygons per volunteer. 27 people, half of the registered volunteers, only drew one polygon, some of them maybe just to test how the application works. But there are also enthusiasts who have put a lot of effort in drawing a large number of polygons. The two top contributors have added 130 and 63 polygons, concentrated in the southwest of the province of Drenthe and in the province of Fryslân respectively. The top contributor is even personally responsible for the last high peak in the number of requests in the second half of March that can be seen in the diagram above.

Regarding the background of the contributors, most people seem to work in the governmental sector. The number of Kadaster employees is rather limited; provinces and municipalities are well represented. GIS professionals from the private sector are present, as well as non-GIS professionals who may use topographic data in their work for orientation purposes. A small number of volunteers are non-professionals who may have local knowledge of geographical names and use topographic maps in their free time. All this is only an educated guess, because many contributors used their private e-mail address rather than their work address and thus it takes some effort to trace everyone back to their working background.

The third and last target, to collect at least 3 polygons each for at least 3 large regions, unfortunately has not been achieved. Area polygons have been drawn for 10 of the 15 large regions, but only for one region – Veluwe – more than one polygon appears in the data set. And even for the Veluwe not more than 2 polygons were drawn.

A more comprehensive overview of some key statistics concerning the data set with geographical area polygons resulting from the Vlakbijnamen application can be found in Appendix B. A list of all contributions, being the area type, area name and remarks for each polygon drawn in the pilot period, can be found in Appendix C.

5.2 Evaluation of the data and the application

5.2.1 Introduction

Although the pilot was overall a success in terms of number of volunteers and total number of polygons drawn, the real value can only be determined by investigating the results. In order to draw conclusions on the usability of the data for processing in the BRT, it is essential to assess the quality. This has been done on the basis of the evaluation criteria listed in Section 3.8, according to the data quality elements in ISO standard 19157. Additionally, the suitability of the method applied in the VGI applications to collect toponymic data can be estimated by looking into the user experiences as shared and discussed in the LinkedIn BRT group.

5.2.2 Completeness

The first quality aspect to assess is completeness. As described in the previous section, not for all polygons all attribute information is provided as requested. Out of 398 polygons, only 319 contain a name, an area type and an e-mail address. One can argue that in most cases a missing area type can be added afterwards during processing of the name by interpretation of aerial images of the area delineated with the polygon. Unlike the situation in TOP10NL, with only point features for geographical areas and the area type as an essential attribute to know what kind of area the name refers to, a polygon provides much more information about the area already: not only its character, but also its size and relative importance compared to other named areas. Moreover, also in cases where the volunteer did provide an area type, the chosen type still has to be assessed for correctness. In some cases, however, it is essential to know the area type to be able to distinguish a field name from a dispersed settlement, for example. Likewise, the absence of an e-mail address is less important if it is possible to verify the name with other sources. But if no other sources can be found and it is desirable to inquire with the volunteer about the name, a missing e-mail address makes this inquiry impossible and might be a reason not to register the name in TOP10NL.

The density of the names existing in an area differs from region to region and depends largely on the region's characteristics. In the polder areas in the western part of the country for example, field names are rare and the names of the polders themselves serve as the main area names. Polder names were not included in the test, as these names are derived from governmental sources. On the other hand, in the ancient cultural landscapes in the eastern and southern parts of the Netherlands field names exist in a very high density. Many of them never even reached the topographic maps due to their small size. Therefore, it is very hard to collect all names and to know if all existing names are provided.

However, the number of objects that can be registered is not limited to the space on the map, as it was at times when only paper maps were produced. In principle, the TOP10NL database provides the opportunity to collect as many names as possible and create a reasonably complete overview of all geographical names in the Netherlands. Only when the toponymic data in TOP10NL have to be considered for placement as text on the topographic maps (1:25,000 and smaller scales), a selection

has to be made according to the available space on the map and with the density of names in other areas of the map taken into account.

Whether it is possible to get enough volunteers with expertise involved in collecting toponymic data of a specific area and providing boundaries for all areas, can only be investigated if this method of crowdsourcing is tested over a longer period. Thanks to the top contributor of the pilot there is already one area in which a fairly complete coverage of polygons for all area names has been established. In Southwest Drenthe, particularly in the former municipalities of Havelte, Diever, Vledder and parts of Ruinen, almost all point features have a corresponding polygon feature and several new area names are added as well.

The same top contributor, together with another Frisian volunteer, contributes to the fact that the distribution of polygons over the country is uneven. In relation to the number of inhabitants or the surface, the provinces of Drenthe and Fryslân are overrepresented in the data set with geographical area polygons. In Drenthe, 160 polygons were drawn, in Fryslân 76. It should be noted that polygons intersecting with more than one province are counted for each of the provinces they intersect with.

In all of the 12 provinces, polygons were drawn and thus, generally speaking, in all parts of the Netherlands names are provided. The lowest numbers are registered for Zeeland (3), Groningen (6), Flevoland (7) and Overijssel (9). These provinces are clearly underrepresented. In addition, all three polygons drawn in Zeeland are named test, which obviously makes them unusable. Other provinces in the data set are more or less represented according to their share in the surface of the Netherlands.

Regarding the area types provided by volunteers, all selected types programmed as domain value for the attribute field Type_gebied have been used. In relation to the number of point features per geographical area type in the point feature layer from TOP10NL, the forest and heathland areas are overrepresented, while the region and field names as well as the dune areas are clearly underrepresented. This may be explained by the fact that forest and heathland areas relate to a terrain type recognizable on aerial images, which makes them easier to delineate than a field name, for example. 68 polygons have been attributed with the area type *overig* (other). With a few exceptions, these areas do not relate to any of the geographical area point features provided in the application, but rather correspond to other areas apparently known by the volunteers. They represent islands, parks, nature areas and even a farm name. There are also a few large regions with this area type, which should have been indicated as *streek, veld* (region, field) according to the BRT data model.

5.2.3 Logical consistency

The logical consistency of the area features can be assessed on multiple grounds. The ISO standard mentions four of them: conceptual consistency, domain consistency, format consistency and topological consistency (ISO 2013). The conceptual consistency is defined as the general adherence of the data to the rules of the conceptual schema, while domain consistency is more specifically about the adherence of the values in the data to the value domains. Whether the data is stored in accordance with the physical structure of the database, is measured with the format consistency. All these three elements relate to the model and structure of a database. In the case of the features drawn in the Vlakbijnamen applications, they should adhere to the model and structure of the TOP10NL data model to be suitable for processing in the TOP10NL database. However, not all three elements fully apply to

the data when still outside of the TOP10NL database. The last element to assess is the adherence to predefined topological characteristics, in this case the topological rules of the TOP10NL database.

The settings of ArcGIS Online, the standard predefined settings and the customizable settings, help to create consistent features. Polygons for example can only be drawn by putting vertices with geographical coordinates on a background map and the system automatically draws line segments between all of them to create a closed polygon. Since the features in the geographical areas layer in TOP10NL do not need to cover the entire surface of the country and do not have to touch each other's boundaries, most of the topological rules that apply to other 'basic' layers, such as terrain, road and water segments, are not applicable here.

A general topological rule that does apply to the geographical area polygons, as well as to features in several other TOP10NL layers, such as functional area and place, is that features are not allowed to intersect themselves. There may be other situations where it is desirable to draw a polygon feature with an eight-like shape, with two surfaces and one vertex as the only connection between these two. ArcGIS Online therefore provides the opportunity to create self-intersecting polygons and it is not possible to disable this with the web map or web mapping application settings. In TOP10NL however, this is not allowed.

ArcGIS Desktop software contains a Check Geometry tool to check a feature layer for elementary logical consistency errors and reports these in a table. Apart from self-intersections, the tool checks for null geometries (polygons without a surface), incorrect ring ordering (vertices ordered in the wrong direction), unclosed rings (first and last vertex are not connected), empty parts (multiple surfaces polygon with a null geometry part), duplicate vertices (two or more vertices with identical coordinates) and several other errors. Executing the Check Geometry tool on the polygon layers from the Vlakbijnamen applications learns that none of these errors occur in the data set.

The consistency of the 'area type' attribute field is enforced by the fact that this a domain attribute. ArcGIS Online allows application users only to choose a valid value from the pull-down list of domain values. The name field is a free input field, just as in TOP10NL. The values for the other attributes of geographical area features will be created or automatically generated when the features are imported in the TOP10NL database. The logical consistency of these attributes is thus enforced by the database settings. This includes the attributes concerning the date of creation or change of a feature as well as the user who created or changed the feature. The TOP10NL database only takes edits within its database into account and overwrites the values ArcGIS Online generated for these latter attributes as soon as the polygons are imported.

Overlapping geographical area polygons are allowed by the validation rules of TOP10NL, since a large region polygon of the '*streek, veld*' type for example can contain smaller field name polygons of the same type. This does not alter the fact that existing overlaps must be logically explainable. The data set contains 688 situations where two polygons intersect each other. These can be multiple situations where the same two features intersect each other. In total, 239 out of 398 polygon features intersect at least one other feature.

Some of the intersections are extremely small, especially when both polygons were drawn by the same user who obviously has tried to draw two polygons next to each other. ArcGIS Online however, does not allow for the snapping of a feature's boundary to the boundary of an adjacent feature. In these cases, it might be desirable to correct the boundaries when the features are processed in the database. In other cases, the intersections are a logical consequence of a larger area polygon containing one or more smaller area polygons.

5.2.4 Positional accuracy

Whether the polygons match with the background layers of the application, and more in particular with the aerial images, can be described as the positional accuracy of the data set. In some cases, there may be no direct relation between the boundaries of a geographical area feature and the physical objects or elements on the aerial images, such as roads or ditches. A common characteristic of geographical area features is that their boundaries are rather fuzzy and sometimes will only be an estimation. In these cases, it is only possible to approximately determine the correctness of the polygon's location and boundaries.

This is especially true for the boundaries of large regions in the data set. They were probably drawn on a smaller scale level, where the physical objects and elements of the aerial images are either difficult to distinguish, or not visible at all, due to the minimum scale level on which the aerial images become visible in the application. This also partly explains the huge difference in delineation of the two polygons representing the Veluwe, apart from the difference in interpretation of the area that is considered to be part of the Veluwe (Figure 15).

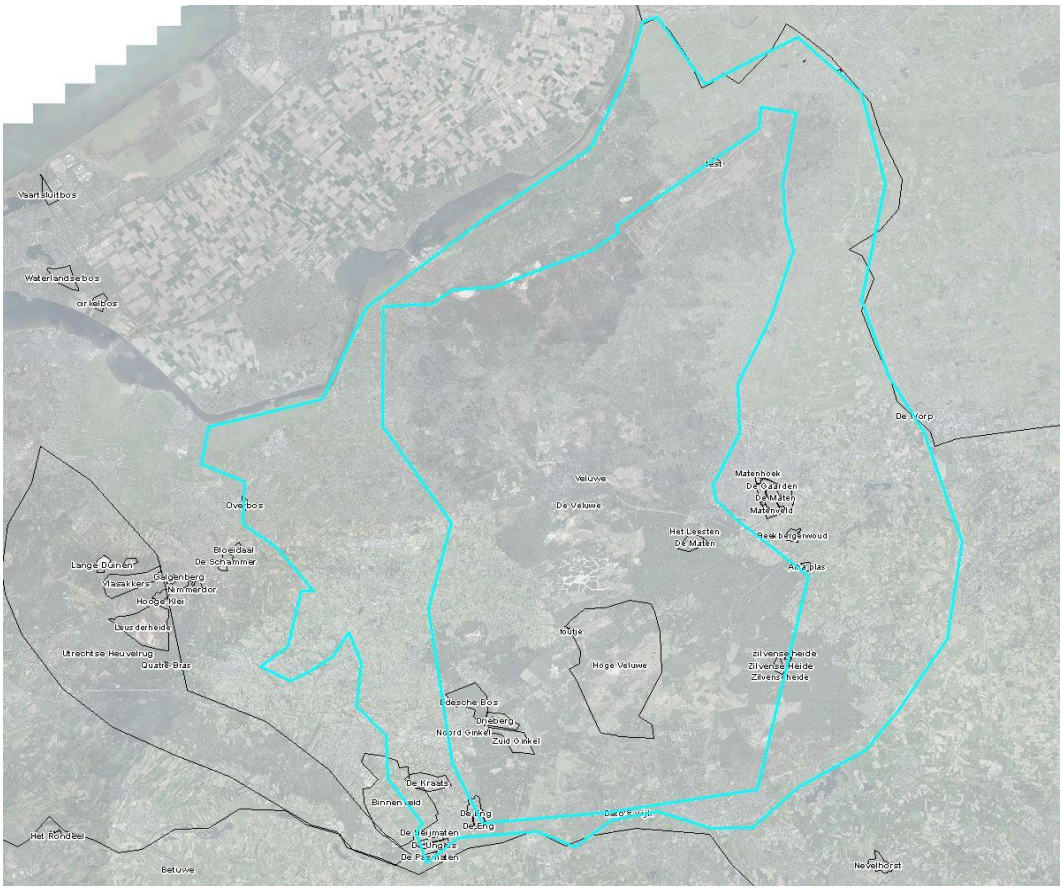


Figure 15. Overlapping polygons indicating the boundaries for the Veluwe region. Also visible are multiple polygons drawn for two smaller areas: Zilvense Heide and De Eng.

In other cases, a more direct relationship with topographic features is present, for example with forest areas or heathland areas: it is easy to compare the location of the polygon boundaries with the location where on aerial images the forest or heathland ends and another land use type begins. For these types of geographical areas, in general the polygon boundaries are drawn quite accurately. Nevertheless, names sometimes refer to a land use that has been partly or completely changed in the course of time. For example, many forest areas on the sandy grounds in the eastern and southern parts of the Netherlands have a name or contain names referring to former heathlands, on which later the current forests have been planted, when the heathlands were no longer needed for grazing sheep and the demand for wood increased.

It is striking that many users seem to have done their best to work as precisely as possible. Many of the smaller field name areas also have a boundary that is related to a road, a canal or another physical element on aerial images. The question is whether these objects can actually be so often delineated on contemporary lines in the landscape, given the fact that they originate from times when the landscape looked completely different and rationalizations through land consolidations had not yet taken place. It is conceivable that some volunteers want to give their polygons an appearance of accuracy by drawing the boundaries as much as possible along real-world objects and elements, thereby neglecting the fuzzy nature of the area's boundaries. In order to show the distinction between features that are known to have a precise and reliable boundary and features having a boundary with a fuzzy character, it might be advisable to add an additional attribute field to the geographical area layer in TOP10NL in order to provide users with information on the accuracy of the feature's boundaries.

5.2.5 Thematic accuracy

The correctness of the attribute information is assessed as the thematic accuracy of the data. This is an important aspect of the quality assessment, since geographical names are provided as attribute information to the polygons. In addition to the names, also the correctness of the area types can be assessed.

As described in Section 5.1, out of 398 polygons drawn in the pilot period, for 319 the attribute information is complete with name, area type and e-mail address. If the provision of this attribute information is considered mandatory, the other 79 features can be regarded as thematically incorrect due to missing data. Whether this should automatically mean disregarding these features for further processing or not, depends on the situation, as discussed in Section 5.2.2.

When assessing the correctness of the names that are present in the data set, it is good to know that no further guidelines have been given to volunteers on spelling and orthography. In case of existing names, they did have the name of the point feature as a reference and could have used it as the name of the polygon, but it was also possible to alter the name according to their own views. To determine the usability for processing in TOP10NL, the names should however be assessed according to the spelling and orthography rules of the BRT as described in the internal guidelines, the *Namenboek* (Names Book).

If one takes a first look at the list of names in the attribute tables, immediately some differences with the naming rules can be noticed. The most striking are that some names start with a space, which

probably is a typing error that has no specific meaning, while a few other names start with a lower-case letter. Even as a general Dutch spelling rule, names should always start with a capital letter. An exception is made for abbreviated first words like *'t* and *'s* (for *het* and *des*, respectively); in these cases, the first full word is capitalized.

In case of the name *'t donders goet* for example, a new area name for a polygon delineating a small forest area south of Dommelen, near Valkenswaard, the correct spelling would have been *'t Donders Goet*. The word *Goet* is also to be capitalized, as a *Namenboek* rule prescribes that all nouns and adjectives in a name should start with a capital letter. Still the spelling of the word *Goet* remains unusual: a common toponymic type name is *goed*, meaning 'domain' or 'estate', as well as 'good' in general language use. The name itself seems to refer to the Dutch expression '*donders goed*', meaning 'very well'. However, another *Namenboek* rule indicates that spelling variants in names of privately owned objects, such as buildings, are allowed and will not be corrected, leaving *Goet* in this case uncorrected (Hogerwerf et al. 2017). Besides, for this specific name and area in Dommelen no information can be found on the internet and in the terrain the name is not indicated on signs, which would require further inquiries with the volunteer before processing (Figure 16).

Figure 16. Polygon and attributes provided for 't donders goet.

The vast majority of the existing geographical names, provided in the Vlakbijnamen application as point features, are written in the 19th-century De Vries and Te Winkel spelling, which became obsolete when it was substituted by the Marchant spelling in 1947. In some cases, names on topographic maps have been modernized over time under the influence of terrain owners, or due to the fact that the name was introduced on a map after 1947. Nevertheless, the Namenboek until 2017 prescribed the De Vries and Te Winkel spelling as a basic rule for all names, referring to the 1947 Orthography Act. In the new version of the Namenboek, the rules and regulations for the registration of names are based on the current Dutch spelling rules. As part of the current project to cooperate with historical societies in checking and complementing the names, it is planned to modernize the spelling of all names in TOP10NL for which no other existing source indicates an alternative spelling, as for *'t Donders Goet* might be the case.

It is interesting to see how volunteers dealt with this spelling issue. Many of them used the names of the point features literally for the names of their polygons and thus in many cases copied the old spelling to the new polygons. Still, quite some people chose to modernize the spelling of a name and changed old spelling words as *bosch*, *esch*, *groote* and *hooge* to the modern spelling variants *bos*, *es*, *grote* and *hoge*. On the other hand, there are only two examples in the data set of modern spelling names that were 'historicized' to the pre-1947 spelling. This may lead to the conclusion that the old spelling is indeed increasingly regarded as obsolete. The fact that many volunteers have retained the old names might also be due to the authoritative character of the names provided as point features.

In one case a remarkable choice has been made to modernize the name *Koggerbosch*, for a forest near Muiderberg, to *Kocherbos*. It appears that many websites refer to this forest and both spellings Kogger- and Kocher- are used, the latter of which predominates. On topographic maps, the name first appears in 1969 as Koggerbosch and has since remained unchanged.

In Fryslân, thanks to one of the top contributors, many Frisian language names have been submitted. Historically, for geographical areas only one name has been registered, in Dutch or in Frisian. It depended on the source, most notably the municipality, what language has been used. With the introduction of TOP10NL and separate attribute fields for Dutch and Frisian names, the possibility arose to register names in both languages. So far little use has been made of this option, but the names provided by volunteers in the *Vlakbijnamen* application suggest that there is a need for it: several Dutch language point feature names have been drawn as a polygon with a Frisian language name. As far as existing names are concerned, it is easy to recognize and explain the name difference. When it comes to newly added areas with a name, it is sometimes more difficult and requires knowledge of Frisian to determine the language of the name. This is the case for names like *Breewar* and *De Wolvetinte*. This makes clear that it would have been an added value to have a separate names field for Frisian names in the *Vlakbijnamen* application as well.

Despite all deviations, misspellings, language differences and newly added areas, in 203 cases the name of a geographical area point feature present in the application is identical to the name of the polygon feature that is drawn closest to it. The fact that the names in TOP10NL are confirmed by a volunteer will probably lead to little or no doubt on their correctness, except for the modernization of the spelling.

As indicated in Section 5.1, the number of polygons drawn for the additional large regions is rather disappointing, since only for the Veluwe region more than one polygon has been drawn. The intention was to determine an average boundary for these areas based on multiple polygons drawn for the same area. The boundaries of the two Veluwe polygons are quite different from each other, indicating that there is indeed some variance in the thoughts about the area belonging to a large region. One polygon is probably based on the concept of the Veluwe as one of the three parts of the province of Gelderland, comprising the whole area of the province north of the Rhine and west of the IJssel river. The other polygon limits the Veluwe to the wooded sandy grounds in this area. The same variance in thoughts applies to the names, since one polygon is named *´Veluwe´* and the other *´De Veluwe´*. The rules in the previous version of the *Namenboek* distinguished for the use of articles at the beginning of a name between polder names, where the articles had to be omitted, and building names, where they basically had to be adopted. The current version of the *Namenboek* is in line with the principles of the

Damsteegt commission, in general not to see articles at the beginning as part of the name, except for well-known cases of populated places like Den Helder, Den Haag, De Bilt etc. Since the *Namenboek* does not apply these spelling rules to street names and populated place names from the BAG, and to names of buildings, administrative and functional areas, the well-known cases the Damsteegt commission refers to and the exception for building names in the previous version of the *Namenboek* have both been considered. Region names are not covered by these exceptions, making the main rule applicable that articles are not part of the name and thus, the name *Veluwe* is registered without its article *De*.

9 of the 14 other large regions have been drawn as a polygon once. Two of them have a name different from the name of the point feature. These are the two examples of 'historicized' spellings referred to earlier in this section. The Hogeland region in the north of the province of Groningen is indicated as '*Hoogeland*', in the old spelling with two o's, while the Meierij region in the province of North Brabant is indicated as '*Meijerij*' with an obsolete 'j'. Besides, the term '*meierij*' (bailiwick) refers to an area governed by a *meier* (bailiff), an office holder appointed by a landowner. The English word 'mayor' is etymologically related to *meier*. The name is not unique: there have been more *meierijen* (bailiwicks) in history. For the sake of completeness, it may be better to refer to the region as the *Meierij van 's-Hertogenbosch* (Bailiwick of 's-Hertogenbosch).

It is difficult to explain why the test failed to have multiple polygons drawn for large regions. One reason might be that the question to draw a polygon for as many large regions as possible, has been overlooked by many volunteers or was asked too freely and has simply been ignored. Another reason can be that most users wanted to limit their contribution to one area or several areas they know well and for which it is easier to determine the boundaries. Maybe they did not feel confident enough about the boundaries of a large region to draw a polygon for any of them.

Regarding the area type attribute, the use of domain values as described in Section 4.2.2 makes typing errors impossible. In many cases however, a volunteer chose for a different area type than has been registered in TOP10NL. Out of the 203 point features matching with an eponymous polygon feature, 67 have a different area type. Some of these differences are well-founded with a view on the aerial images and also explained in the Remarks field. Examples are forest areas that were felled in order to be restored as heathland areas, or field names in TOP10NL that in reality refer to a water body and have been indicated with *overig* (other) as the area type of the polygon. Nevertheless, most deviations make little or no sense, either because no attention was paid to the correct area type after drawing the polygon or maybe because of a lack of insight into the meaning of the types.

For newly added names, most provided area types seem to be correct when based on the land use visible on aerial images. But also here, some unexpected choices are made.

In general, it can be said that the Remarks field is a valuable addition to the attributes 'area type' and 'name'. It provides information and explanations for choices made by volunteers, and additional information on the origin of names that is useful when processing the polygons and names for TOP10NL.

The option to add photos of other files to the polygons, to illustrate or explain the contribution, has been used only once in the pilot period. For the field name *De Marren*, near Akkrum in Fryslân, a polygon with very specific boundaries has been drawn. In the Remarks field the user suggests that the name refers to a former lake that was located here, the *Henshuistermeer*. Even on the oldest topographic maps of 200 years ago, this lake does not appear and the area has since always been a meadow area. The added file shows a visualization of the height model of the area, in all probability based on the *Actueel Hoogtebestand Nederland* (AHN, Current Height File of the Netherlands). The picture indeed clearly shows that the delineated area for *De Marren* lies, for Dutch concepts, significantly lower than the surrounding area (Figure 17). A query on the terrain heights in the AHN Viewer learns that the altitude difference is 1.5 meters on average. This, together with the fact that the Frisian name *De Marren* (litt. The Lakes, in modern Frisian) seems to refer to one or more lakes, underpins the claim that the name is linked to this low-lying area. In other words, the added file contains essential information to verify the quality of the contribution. Despite the little use made of the option, which may also have other causes, like the impossibility to edit a contribution by adding a file later, it definitely can have an added value to add a file.

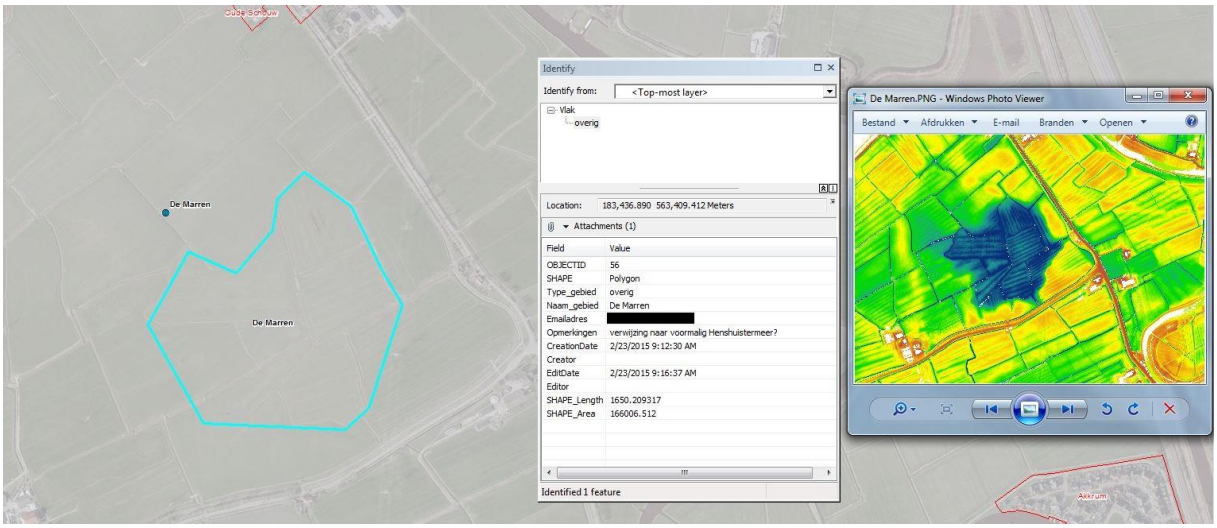


Figure 17. Polygon for De Marren, including provided attributes and attachment with a visualization of altitude data (lowest altitudes are blue, highest altitudes are red).

5.2.6 Temporal quality

The quality element the most difficult to assess is the temporal quality, at least when the question has to be answered whether the name is still in use. In the process of cooperation with historical societies to check and complement geographical names, quite some names provided by the societies seem to be historical names. This becomes clear when societies have used an old cadastral map to delineate parcel names, while on the current topography these parcels cannot be recognized and do not exist anymore. These names are excluded in advance from registration, as the BRT should only contain data that is still current. For slightly larger areas that are not present in TOP10NL yet, it is much more difficult to determine if the name is still in use. In the absence of leads in the topography, the only option is to check the use of the name on the internet. If this is not possible, based on the reputation of the historical society with other names the consideration has to be made if the society is reliable enough to register the name without further verification.

In case of newly added names provided by individual volunteers in the *Vlakbijnamen* application, reliability can only be determined after multiple features have been submitted and assessed by the volunteer in question. If a historical society is cooperating in the same area as the name is provided for, the name can be cross-checked with the historical society. This is already being done occasionally for name-related reports coming in through the BRT-BGT user feedback system.

As far as the existence of the field area to which a name refers is concerned, there are no examples found in the data set of polygons drawn for areas that have disappeared due to the building of a new residential area on the site.

As mentioned in Section 5.2.3, the temporal validity of the attributes indicating the date and time of drawing or editing of a feature is enforced by the settings of ArcGIS Online. Once the features are imported into the TOP10NL database, the values for these attributes will be overwritten.

5.2.7 User experiences

The success of the pilot project and the usability of the method and data should not only be assessed on the basis of the amount and quality of the data, but also of the quality of the application and its functionalities. User experiences are a good indicator for this, and for the attitude towards the method of data collection.

As mentioned earlier, in the LinkedIn group of the BRT an extensive discussion arose following the message with a call to participate in the pilot. A large number of group members shared their experiences and views regarding the application.

What all comments have in common is a positive opinion towards the initiative to make a VGI application and give the general public the opportunity to participate in the maintenance process of the BRT. All participants enjoyed using the application and several indicate it makes sense for Kadaster to use the knowledge of the crowd and for themselves to share their knowledge with the purpose of using it in a governmental registration. Several people also expressed their interest in the results and the outcome of the pilot and the research.

Regarding the request of the pilot, someone suggested it may be easier to check and correct a name than to indicate the boundaries of the related area. Another asks from which perspective the large regions should be delineated, based on the example of the Twente region: should the geographical and cultural boundaries be leading, or the contemporary governmental boundaries. The latter include a larger area; due to municipal mergers, areas that are historically, geographically and culturally regarded as part of the adjacent Salland region now belong to a municipality participating in the Twente Region governmental partnership. The answer here was that people should and may decide for themselves what boundaries they want to draw, based on what choices and considerations they want to make and apply.

Other participants refer to the historical character of some area names and wonder what should be done with areas and names that no longer fit the current topography, or in other cases wonder if areas can have the same boundaries as several decades ago as a result of large-scale land consolidations with major adjustments to the landscape.

From their practical experiences with the *Vlakbijnamen* application users suggest to change the color of just drawn polygons or in general to improve their visibility. The underlying idea to divide the application in two, one as a drawing environment and another one as an overview of all the contributions, including one's own, is probably not understood.

Additional practical suggestions include an undo function to correct mistakes, the possibility to adjust one's own contributions afterwards, for example to add comments or files, and the option to upload existing GIS files with area boundaries and names to make these visible in the application. This would make redrawing of polygons superfluous and opens up the potential for geotagging of documents.

One of the participants also gave suggestions to expand the application with the base layers of TOP10NL, in order to make snapping of the area boundaries to the boundaries of terrain, road and water features possible, and to include features from other name categories, such as water names. As far as snapping to other layers is concerned, the question is whether geographical areas should match with the underlying base layers of TOP10NL and whether this unjustly suggests that the boundaries of field names are known exactly and in detail.

Furthermore, attention is being asked for the differences in visualization and behavior of the application in several web browsers. It is said that in Internet Explorer, entering information can be finished with an extra tab, while in Firefox for example this option is absent. This may of course also relate to the functionalities of the web browser.

Several users suggest to seek cooperation with other organizations that may be able to help with the collection of geographical names. These include nature conservation organizations, like Staatsbosbeheer and Natuurmonumenten, for the names on their properties, and the Meertens Institute for their collection of field names. One user of a provincial government offers cooperation himself by sharing data sets of his own organization containing area boundaries.

5.3 Processing of the data

It becomes clear from the evaluation of the data that, while a majority of the polygons and names are of good quality and seem to be usable, a significant part needs thorough investigation or adjustments before further processing. Some features lack essential information, such as the name of the area, and cannot be used. All in all, quality assessment may very well be the most important step in processing the data. This may take some extra time, but this method of collecting and processing data will still be much faster compared to the earlier workflow including field work activities, when it took a few months to fully process one map sheet in TOP10NL only.

As described in Section 3.7, there are various options to include the collection of toponymic data by means of a VGI application in the maintenance process of the BRT. In order to benefit from the knowledge of the historical societies and enable them to function as an additional quality check on the data, it would be wise to involve them in the processing. On the other hand, the experiences with the user feedback system of the BRT show that it is important for the motivation of users to process a contribution as soon as possible and to inform them of its status. The fact that a large part of the toponymic data in TOP10NL, including geographical areas, functional areas and places, has no

topological relationships with other feature classes and new features for example do not have to be fitted into existing topography, makes it even easier to do so. The most obvious variant is therefore to directly process a toponymic data feature submitted through the VGI application in TOP10NL, after an internal quality assessment and an additional quality check of a cooperating historical society. The latter of course depends on the availability of a cooperating society in the area the feature is located.

Dedicated staff members with sufficient knowledge, experience and insight in toponymy and toponymic data are essential for a good and consistent assessment and registration of these data. As a team they can handle both the contributions from historical societies and those from individual volunteers through the VGI application. Just as in the current situation two employees are designated to maintain all contacts with the historical societies and two others – not necessarily part of the toponymic data team – respond to user reports submitted through the general BRT user feedback system, at least two members of this team should be assigned with the task of processing contributions through the VGI application.

In order to ensure that all the desirable information will be provided and can be easily recognized, assessed and processed, the settings of the data collection tools in the application should be aimed at preventing incorrect contributions and giving users the information, they need. Enforcing the provision of all attribute information, including various name fields to make the distinction between Dutch, Frisian and type names, visualizing additional layers to help users locating the correct real-world area or object, and indicating the status of the contribution in the process are examples of possible improvements to the application. Obviously, it would be interesting as well to add editable layers of other feature classes to the application, such as water and building names. After the geographical area point features have been transformed into polygon features, the application should allow users to edit these polygons if they want to adjust the boundaries or the name, instead of forcing them to draw a new feature.

At the moment the user feedback system also provides the opportunity to report errors and new features for all feature classes in the BRT. Since the proposed data collection process for toponymic data is somehow related to that of the processing of feedback reports, an integration of the VGI application and the user feedback system is a valid option to consider, although the feasibility of this option is strongly influenced by dependencies of the user feedback system with other processes and interests.

At least equally important for a correct registration is the availability of extensive rules and regulations with all necessary and desirable requirements for toponymic data. The current version of the *Namenboek* contains all basic rules and regulations for the registration of geographical names and can serve as a good basis for determining the correct spelling of names provided by individual volunteers. Nevertheless, as can be seen in the output data of the pilot application, some very specific cases might arise where the existing rules do not give a clear answer and even experienced employees wonder how to deal with them. Substantive supervision of the process and mutual coordination therefore remains crucial to maintain consistency and reliability. Periodical team consultations, discussion of doubtful cases and recording of decisions and additional mutual agreements are a way to get and keep everyone on the same line.

In the ideal circumstance that a national names authority responsible for geographical names standardization will be established in the Netherlands, the team within Kadaster responsible for processing names in the BRT would have a link to this authority. The rules and regulations adhered to also would have to be aligned with the national standard in this case.

Assuming the implementation of a separate VGI application similar to the *Vlakbijnamen* application in the previously outlined process, the processing would start as soon as a feature in this application is submitted. If this function has been added to the application, an employee marks the contribution with the status 'under investigation' and starts a quality assessment, including a background check on the name and possibly the area. If deemed necessary, inquiries can be made with the submitter for further explanation. Then the spelling and orthography of the name is assessed and if applicable, adjusted according to the agreed rules and regulations. In case of area names, the polygon is validated and adjusted to the established topology, geometry and attribute rules. As a final check, the validated version of the feature can be submitted to the historical society for approval. Subsequently, the feature is registered in the TOP10NL database and visualized on all relevant BRT map products (TOP25, TOP50 etc.).

6. Conclusions and recommendations

In order to draw conclusions about the research, the research questions will first be answered, followed by a general conclusion and recommendations for the future.

6.1 What are the requirements for toponymic data?

1.1 What toponymic data are present in the BRT?

Mainly based on the Kadaster Act, the data model of the Key Register of Topography (*Basisregistratie Topografie*, BRT) distinguishes 13 feature classes, each containing a specific thematic part of the topographic data: road segments, water segments, terrain segments, buildings, relief, populated places, geographical areas, administrative areas, etc. In addition to their geometry, all features have attributes providing additional information to the feature. These attributes vary according to the feature class the feature is part of. With the exception of two, all feature classes have name attributes that can be regarded as toponyms. The importance of the name fields differs per feature class or even per feature and depends on the character of the object it represents. Geographical areas for example, often have boundaries that do not coincide with topographic objects, making the name essential to identify the area, while terrain segments usually do not have their own name but are part of a larger area with a name.

1.2 How were these data collected and maintained in the past?

Many names in TOP10NL are collected and maintained as part of the database, for the sake of completeness or for analysis purposes, but not visualized on the map. Originally, however, toponymic data collection was fully focused on making a topographic map. Data collection for the first national topographic maps started from the end of the eighteenth century and has been performed uninterruptedly since the creation of the Topographic Bureau and the Military Reconnaissance Agency in 1815, which were later merged to become the Topographic Survey (*Topografische Dienst*, TD). Throughout the history of these agencies, geographical names were collected during field work visits, mainly by interviewing the local population and by inquiring local governments. After the Topographic Survey became part of Kadaster, all field work activities were discontinued and in 2009 replaced by the introduction of 360-degree street view images in the maintenance process. For many information gathered in the field this was an acceptable solution, but not for toponymic data, as names are usually not present on signs or the texts on the signs are not legible from the images.

1.3 What are the legal, functional or other requirements for BRT data?

The Kadaster Act prescribes the basic legal requirements for BRT data. It stipulates that all objects included in the BRT must be in accordance with the physical reality at the time of the last update of the area in which the object is present. As toponymic data cannot be seen on aerial images and are not part of the main update process, their temporal accuracy cannot be guaranteed and an additional data collection process is needed.

1.4 What are the legal, functional or other requirements for toponymic data?

Despite several efforts in the nineteenth century, geographical names in the Netherlands were not yet standardized according to generally accepted rules and regulations by the time of introduction of the Dutch Language Orthography Act in 1947. Therefore, in the Act the old spelling retained its validity for geographical names in the Netherlands. Consistent spelling and orthography rules for geographical names were proposed by a spelling commission in 1973, but were never implemented. In 2005 a new

Spelling Act came into force, prescribing the general use of the current Dutch spelling rules, without excluding their application to geographical names. This would mean that toponymic data in the BRT and other key register should adhere to these spelling rules.

According to the European Charter for Regional and Minority Languages signed and ratified by the Netherlands, the use of traditional and correct forms of Frisian language place names must be allowed and encouraged. In the BRT this is implemented by creating separate attribute fields for Frisian language names in several feature classes.

1.5 How can these be expressed as rules and regulations for a data collection system?

Standardization rules and regulations should be applied to all key registers containing geographical names in order to create consistency in the spelling and orthography of the names. The United Nations Group of Experts on Geographical Names (UNGEGN) promotes standardization of names on an international level and calls on member states to take standardization measures on national level as well.

In concrete terms this means that the many names registered according to the old spelling and orthography rules should be modernized. In the Key Register of Addresses and Buildings (*Basisregistratie Adressen en Gebouwen*, BAG), it is mainly about getting the municipalities aligned to register street names and populated place names according to consistent orthography rules. Regarding area names, the boundaries of the area should also be demarcated. This can be done by crowdsourcing the data collection. When multiple volunteers draw the boundaries of the same area, an average can be calculated to be the fuzzy boundary of the area. This fuzzy character of the boundaries should be able to be registered in the TOP10NL database, for example with an extra attribute field.

1.6 What other data sources containing toponyms are available?

There are many data sources available containing toponymic data. Traditionally, the Topographic Survey used the local population as an important source for names, being a form of crowdsourcing *avant la lettre*. Other important sources included local governments and national governmental agencies, such as Rijkswaterstaat and the Hydrographic Service.

Nowadays, the BAG is in important source for geographical names registered by the municipalities. There are several commercial companies offering products with toponymic data, including tech giants like Google and Apple and producers of navigation apps like TomTom and Here, but their quality is variable and cannot be guaranteed. The same applies to the data from VGI platforms like OpenStreetMap, GeoNames and Wikimapia. The Meertens Institute in Amsterdam maintains a very valuable collection of field names it collected over decades by means of field surveying and interviewing the local population. This source, however, is not digitized and thus not directly available for processing.

1.7 What methods of crowdsourcing exist?

There are various ways of collecting Volunteered Geographic Information (VGI). Some involve active data collection, meaning volunteers consciously contributing to the purpose of collecting VGI, like in OpenStreetMap for example, while passive data collection means re-using available data that was made for other purposes, such as geotagged photos or messages on social media. Useful methods for

national mapping agencies (NMAs) include user reporting, applying change detection techniques with existing VGI data, or allowing direct contribution by volunteers.

1.8 Which of these methods would answer the requirements of BRT and toponymic data?
User reporting is already applied in the combined BRT-BGT user feedback system. Feedback relating to toponymic data is received frequently and contributes to the quality of these data in the BRT. Change detection is less suitable for toponymic data due to the variable quality of existing VGI data sources. Direct contribution of volunteers in a VGI application would therefore best answer the requirements of toponymic and BRT data.

1.9 How are toponymic data handled by other national mapping agencies?
The products and methods in the three NMAs that were selected to answer this question – Sweden, Switzerland and Belgium – mutually differ. Although the update frequency is generally lower than in the Netherlands, all countries pay considerable attention to the collection and maintenance of toponymic data in their databases. Names are collected through field work or in cooperation with local or regional governments. All countries have standardized their names, based on rules and regulations set up either by the NMA or by a commission consisting of representatives from science, governmental agencies and other stakeholders.

1.10 What are the experiences in the use of crowdsourced toponymic data by NMAs?
Many NMAs in Europe have gained experience with the collection or use of VGI. Sweden's Lantmäteriet tested a VGI application to collect vernacular names in its home town Gävle, but did not follow up the project. The British Ordnance Survey ran a more successful project with a similar purpose, to collect popular names of coastal objects in cooperation with the Maritime and Coastguard Agency, which has continued to this day. In Spain the toponymic data of IGN España has been improved with the help of volunteers providing correct names in an VGI application designed as a town conquer game. By far the most experience has been gained in several countries with user reporting through user feedback systems.

1.11 How would the use of VGI affect the workflow of processing toponymic data at Kadaster?
Just like the current project to check and complement the toponymic data in TOP10NL in cooperation with local historical societies, the best way to integrate a VGI application in the workflow is in a separate maintenance process. Historical societies can play a role to check the names contributed by individual volunteers. A dedicated team of employees with knowledge and insight in the rules and regulations for geographical names is indispensable for a consistent treatment of these names.

1.12 According to what criteria can toponymic VGI data be evaluated?
To be able to assess the quality of the data resulting from the VGI application that has been built for this research, evaluation criteria have been set up according to five data quality elements mentioned in ISO standard 19157: completeness, logical consistency, positional accuracy, thematic accuracy and temporal quality. Criteria have been based on experiences with data quality and existing rules and regulations for toponymic and BRT data.

6.2 How to build a VGI application to collect toponymic data?

2.1 What are the requirements for a VGI application?

The requirements for the VGI application to be tested in a pilot project have been divided into two main categories: external and internal requirements. External requirements are about the context of the application and can be found by answering the five W questions: who, what, where, when and why. For who is the application and who is building it, what data is tested, where is the application hosted and for what area are the data collected, when does the pilot project take place and what is the assignment for volunteers that will use the VGI application: to draw polygons delineating the boundaries of geographical area names and to provide the correct area type and name.

The main drawback for using an existing VGI platform, such as OpenStreetMap, GeoNames or Wikimapia, to collect toponymic data is the fact that the process is more difficult to control and that the tooling is more complicated to explain to potential contributors. Therefore it is preferable to build an application specifically aimed for the purpose, with all the desired and necessary settings.

Internal requirements, for the application itself, have been divided into five categories: visual, editing, tooling, interface and processing requirements. The prioritization was done by using the MoSCoW method to divide the requirements for each category in Must haves, Should haves, Could haves and Won't haves.

2.2 How to set up a VGI application?

The VGI application has been built by using the ArcGIS Online platform, which interoperates with the ArcGIS Desktop software used for the maintenance of TOP10NL. An editable layer has been created to draw the polygons for geographical areas, two web maps have been made with all the layers that are visible to the volunteers and two web mapping applications to set the layout and tooling of the applications themselves. One application is used as an editing environment, the other is meant to provide an overview of all contributions.

Preparing and building web mapping applications is an intensive process and requires quite some knowledge and insight in GIS and the required settings, but ArcGIS Online is a user-friendly platform that makes it fairly easy to do, also for less-experienced application builders.

6.3 How to evaluate VGI for toponymic data?

3.1 What is the quality of the data collected with the VGI application?

In a 1.5-month pilot period to test the application, 398 polygons were drawn in the *Vlakbijnamen* application. The vast majority of them are flawless and usable. Examples of errors occurring in the data are missing attributes, small overlaps between polygons and spelling and orthography errors in the names. Polygons have been drawn in all parts of the Netherlands and for all selected geographical area types. Logical consistency is mostly enforced by the settings of the application. Volunteers have done their best to draw their polygons positionally accurate, sometimes even a little too good considering the fuzzy character of most area boundaries. The spelling of several existing names has been modernized by users, indicating a sense to apply the current Dutch spelling rules to geographical names. A request to draw as many polygons as possible for a selected number of well-known large regions in the Netherlands, in order to test if it is possible to distill an average boundary from multiple contributions, is insufficiently satisfied and this test as a result has failed.

Remarks from users of the applications were all positive and give an incentive to implement this method of using VGI in the maintenance process of the BRT. Several suggestions for improvement of the application have been done. The tested structure with two separate applications, one to draw the polygons and another one to show all polygons drawn by the user and by others, may not have been understood by all users.

3.2 How can these data be processed at Kadaster?

Based on the experiences with the BGT-BRT user feedback system, the best option seems to process contributions as soon as possible after they have been made in the VGI application. Quality assessment is an important aspect of the process, requiring dedicated employees with sufficient knowledge and insight in the rules and regulations for toponymic data. Historical societies can do a last verification check before the data are registered in the database and the names are visualized on the topographic maps.

6.4 General conclusions

Based on background research into the requirements for toponymic data and the usability of available data sources, it seemed a very promising idea to build a VGI application in order to test the collection of boundaries and names for the geographical areas in TOP10NL with the help of individual volunteers. The resulting data and the experiences of volunteers in this pilot study confirm that this can be a successful method of data collection and indicate a potential for implementation in the maintenance process of the BRT.

From 2009 many toponymic data could no longer be maintained and their quality and temporal accuracy no longer guaranteed. Names are not present on aerial images; street view images cannot replace the field work activities for this and external data sources provide not enough information. Crowdsourcing in advance seemed an acceptable alternative and was the reason to start this research and run a pilot. Meanwhile, after the failure of the first pilot project to test updating toponymic data in cooperation with municipalities, it remained as more or less one of the last possible solutions. The successful second pilot project in which cooperation was sought with local historical societies to update the toponymic data, and the subsequent setup of a new update and maintenance process based on this pilot, is in fact the first step in applying direct contributions of, in this case, a specialized crowd. As was already foreseen in the project proposal to set up this new maintenance process, a VGI application open to all who have knowledge of geographical names and want to share it, would be a perfect addition to the information coming from local historical societies. This provides the opportunity to get nationwide coverage for the collection of names and creates the broadest possible basis for knowledge and insight in the names that are in circulation among the population.

Knowledge and insight in geographical names and the rules and regulations for toponymic data are also essential prerequisites for employees of Kadaster who are processing these data in the BRT. A dedicated team of experienced employees is necessary to guarantee quality and maintain all legal, functional and other requirements for toponymic and BRT data. As a key register and part of a system of key registers, the BRT should contain consistent data that matches with other registers. The Topographic Survey once played a pioneering role in this, but despite efforts in the past no standardization of geographical names on a national level has been established yet. The rules and

regulations for toponymic data in the BRT already being updated to the current Dutch spelling rules, efforts should now be focused on coordination with other key registers and stakeholders in names registration to establish a national standard for toponymic data and implement this, like in almost all other countries in Europe. A governmental agency or a commission with representatives from all stakeholders should be designated as a national names authority and assigned with the task of setting up and subsequently supervising the application of the required rules and regulations. The team within Kadaster responsible for toponymic data of the BRT should ideally be represented in this body.

The question remains whether the tested method of VGI data collection also works for other names categories. Quite some user reports submitted through the BGT-BRT user feedback system are related to toponymic data of other categories, and even in the pilot VGI application meant to collect area names several polygons for other names categories were drawn, such as water names and even building names. This suggests a need and willingness among map users and other volunteers to contribute with information on these types of names as well.

Still, the demarcation of boundaries for area features in the pilot is a specific aspect of toponymic data collection, that somehow might have influenced the outcome. The fuzzy character of most area boundaries is unusual to most users and to employees, who otherwise always strive to register the topography as accurately as possible. The accuracy of area boundaries and their fuzzy character should therefore be registered in the TOP10NL database and provided to BRT users, for example through an additional attribute field for the geographical areas feature class.

The test to investigate the possibility of calculating an average boundary for well-known large regions out of multiple polygons for the same region, drawn by as many different volunteers as possible, has failed due to insufficient compliance with the request to draw these polygons. This may have been caused by the focus of many volunteers on their own living environment, or because the request has not been clear enough. Another reason may be that the fuzzy character of the boundaries make that some people feel not confident enough about the boundaries to draw them. This also might play a role among local historical societies that do not provide area boundaries.

An alternative method of collecting these boundaries is by providing an estimation of the area boundaries as Kadaster itself and giving volunteers the opportunity to edit these boundaries in case they feel adjustments are necessary. The correctness of the names could be tested by providing unnamed polygons and ask volunteers to name them, without being able to see each other's contributions. The latter option, however, requires a sufficient number of contributions to get workable results and thus has actually the same disadvantage as the test to calculate an average boundary out of multiple polygons.

6.5 Recommendations

As the research shows that it is possible to crowdsource the collection of toponymic BRT data with a VGI application in the case of geographical area features, the most important recommendation is to apply this method in the maintenance process of the BRT. A VGI application similar to the *Vlakbijnamen* applications, but as one application with already drawn polygons visible in the drawing environment, should include all toponymic data of the BRT and allow volunteers to edit the existing features copied from TOP10NL. By processing the contributions as soon as possible and giving local historical societies,

if possible, the option to confirm correctness, the VGI application could be a valuable and desirable addition to the information provided by local historical societies in the toponymic maintenance process started last year, as well as to the user reports submitted through the BGT-BRT user feedback system.

To make sure all area features in TOP10NL can be converted from point to polygon features within a reasonable period of time, it is advisable for Kadaster to draw their polygons and estimate the correct demarcation. If not provided by the local historical society, the location of the boundaries can be based on preserved names models from the 1980s, the location and text size of the area names on old topographic maps, or the information on existing data sources, such as the nautical charts of the Hydrographic Service for off-shore and coastal names.

A data model change is needed to indicate the fuzzy character of the boundaries of many area features, either by an additional attribute or by a different rendering of the boundaries themselves. This information is essential for users to decide what boundaries and surface data can be used without a doubt in visualizations and calculations, and what features should be regarded as just an estimation.

This way, Kadaster contributes to the pursuit of completeness, reliability and temporal accuracy of toponymic data, which gives the BRT considerable added value compared to other key registers in the geographical domain and emphasizes Kadaster's leading role in the field of geo-information.

A final but certainly not less important recommendation is to focus with unremitting efforts on the standardization of geographical names in the Netherlands. After more than 200 years of governmental map making and with nearly all other developed countries having managed to do so, it is about time to align the rules and regulations for the registration of geographical names and agree on a national standard. Doing so would benefit not only the producers and users of geographical information, but the society as a whole. Geographical names are an indispensable part of daily life, in locating, navigating, identification, description and many other purposes. The government should acknowledge this importance and facilitate a correct and consistent registration and use of geographical names.

References

AHN (2018). "Actueel Hoogtebestand Nederland." Product information. Retrieved 01-07-2018, from http://www.ahn.nl/.

AIV (2018). "Ontdek onze producten." Retrieved 13-05-2018, from https://overheid.vlaanderen.be/informatie-vlaanderen/producten-diensten.

Bundesrat (2018). "Verordnung über die geografischen Namen." Retrieved 13-05-2018, from https://www.admin.ch/opc/de/classified-compilation/20071090/index.html.

cadastre.ch (2018). "Geografische Namen in der amtlichen Vermessung." Retrieved 13-05-2018, from https://www.cadastre.ch/de/av/names.html.

Capineri, C., M. Haklay, H. Huang, V. Antoniou, J. Kettunen, F. Ostermann and R. Purves (2016). European handbook of crowdsourced geographic information, Ubiquity Press. ISBN 1909188816.

Castellote, J., J. Huerta, J. Pescador and M. Brown (2013). Towns Conquer: A Gamified application to collect geographical names (vernacular names/toponyms). AGILE 2013. Leuven, Belgium.

Dienst der Hydrografie (2018). "Dienst der Hydrografie." Corporate website. Retrieved 01-06-2018, from https://www.defensie.nl/organisatie/marine/eenheden/dienst-der-hydrografie.

Dings, R. (2017). Over straatnamen met name, Waarom onze straten heten zoals ze heten. Amsterdam, Nijgh & Van Ditmar. ISBN 9789038803524.

Esri (2018a). "ArcGIS Desktop." Product information. Retrieved 01-06-2018, from http://desktop.arcgis.com/.

Esri (2018b). "ArcGIS Online." Product information. Retrieved 01-06-2018, from https://www.esri.com/nl-nl/arcgis/products/arcgis-online/overview.

Esri (2018c). "Story Maps." Product information. Retrieved 01-06-2018, from https://storymaps.arcgis.com/.

Fiebrich, C. (2009). "History of surface weather observations in the United States." Earth-Science Reviews 93(3-4): pp. 77-84.

Fonte, C., V. Antoniou, L. Bastin, L. Bayas, L. See and R. Vatseva (2017). Assessing VGI data quality. Mapping and the Citizen Sensor. L. See, G. Foody, S. Fritz, et al., Ubiquity Press: pp. 137-163.

Gemeente Rotterdam (2018). "Algemene Plaatselijke Verordening (APV)." Retrieved 01-07-2018, from https://www.rotterdam.nl/bestuur-organisatie/apv/.

GeoNames (2018). "GeoNames." Platform website. Retrieved 01-06-2018, from http://www.geonames.org/.

Goodchild, M. (2011). Citizens as Sensors: The World of Volunteered Geography. The Map Reader: Theories of Mapping Practice and Cartographic Representation. M. Dodge, R. Kitchin and C. Perkins, John Wiley & Sons: pp. 370-378.

Google (2018). "Google Maps." Platform website. Retrieved 01-06-2018, from https://maps.google.com.

Haklay, M., V. Antoniou, S. Basiouka and R. Soden (2018). "Towns Conquer – Gamification approach to validation of IGN National Toponyms database of Spain." Crowdsourcing and Government. Retrieved 01-06-2018, from https://crowdgov.wordpress.com/case-studies/towns-conquer-gamification-approach-to-validation-of-ign-national-toponyms-database-of-spain/.

Here (2018). "Here Technologies." Corporate website. Retrieved 01-06-2018, from https://www.here.com/.

Het Waterschapshuis (2018). "Het Waterschapshuis." Corporate website. Retrieved 01-06-2018, from https://www.hetwaterschapshuis.nl.

Hogerwerf, J. (2017). Toponymic data and map production in the Netherlands: from field work to crowd sourcing. Eleventh United Nations Conference on the Standardization of Geographical Names. New York, UNGEGN. E/CONF.105/87/CRP.87.

Hogerwerf, J., B. de Ruiter and C. van der Touw (2017). Namenboek BRT. Internal guidelines for the registration of toponymic data in the BRT. Kadaster Geo-Informatie. Zwolle, Kadaster.

Howe, J. (2006). "Crowdsourcing: A definition." Retrieved 01-06-2018, from http://www.crowdsourcing.com/cs/2006/06/crowdsourcing_a.html.

IGN (2014). Workshop Volunteered Geographic Information - A Survey of National and Regional Mapping Agencies. In COST Action TD1202 WG 3, IGN, Paris.

ISO (2013). International standard ISO 19157: 2013: Geographic Information - Data Quality. International Organization for Standardization (ISO).

Kadaster (2014). "Inventaris Kadastermuseum." Retrieved 01-11-2014, from http://www.kadaster.nl/web/Themas/Themapaginas/Alle-dossierartikelen/Inventaris-Kadastermuseum.htm.

Kadaster (2017). Basisregistratie Topografie: Catalogus en Productspecificaties. 1.2.0.

Kadaster (2018a). "Basisregistratie Adressen en Gebouwen." Product information. Retrieved 01-07-2018, from https://www.kadaster.nl/basisregistratie-adressen-en-gebouwen.

Kadaster (2018b). Basisregistratie Adressen en Gebouwen, data set, release 08-01-2018. Apeldoorn, Kadaster.

Kadaster (2018c). "Basisregistratie Grootschalige Topografie." Product information. Retrieved 01-07-2018, from https://www.kadaster.nl/bgt.

Kadaster (2018d). Basisregistratie Grootschalige Topografie, data set, release January 2018. Apeldoorn, Kadaster.

Kadaster (2018e). "Basisregistratie Topografie." Product information. Retrieved 01-07-2018, from https://www.kadaster.nl/brt.

Kadaster (2018f). "Krayenhoffkaart." Product information. Retrieved 01-06-2018, from https://www.kadaster.nl/-/krayenhoffkaart.

KB (2018). "KB-catalogus." Retrieved 01-06-2018, from https://www.kb.nl/digitale-bronnen.

Kooij, F., A. de Boer and L. Jessen (2018). Catalogus Basisregistratie Adressen en Gebouwen 2018. Den Haag, Ministerie van Binnenlandse Zaken en Koninkrijksrelaties.

Lantmäteriet (2018a). "Lantmäteriet." Corporate website. Retrieved 13-05-2018, from https://www.lantmateriet.se/.

Lantmäteriet (2018b). "Ortnamn." Retrieved 13-05-2018, from https://www.lantmateriet.se/sv/Kartor-och-geografisk-information/Ortnamn/.

Logius (2018). "Stelselcatalogus." Retrieved 01-06-2018, from http://www.stelselvanbasisregistraties.nl/authentieke_gegevens/.

Meertens Instituut (2018a). "Archief van de Nederlands-Belgische Woordenlijstcommissie, 1960 - 1986." Retrieved 01-06-2018, from http://www.meertens.knaw.nl/archieven/index.php?action=expand&querystring_b64=aW5ob3VkPXdvb3JkZW5saWpzdCZhbXA7c2VhcmNoX3N1Ym1pdHRlZD1ab2Vr&id=275.

Meertens Instituut (2018b). "Digitaliseren van de veldnamen (Divena)." Retrieved 01-06-2018, from http://www.meertens.knaw.nl/cms/nl/medewerkers/23-algemeen/meertens-instituut/67366-digitaliseren-van-de-veldnamen-divena.

Miller-Rushing, A., R. Primack and R. Bonney (2012). "The history of public participation in ecological research." Frontiers in Ecology and the Environment 10(6): pp. 285-290.

Naturalis (2018). "Afscheid van Natuurkaart.nl." Retrieved 01-06-2018, from https://www.naturalis.nl/nl/kennis/onderzoek/zelf-ontdekken/natuursites/afscheid-van-natuurkaartnl/.

Nederlands-Belgische Woordenlijstcommissie Aardrijkskundige namen binnen Nederland (1973). Rapport van de Nederlands-Belgische Woordenlijstcommissie Aardrijkskundige namen binnen Nederland. B. C. Damsteegt, D. P. Blok, C. Kruyskamp, J. E. Romein and A. A. Weijnen. Amsterdam.

Nederlandse Taalunie (2018). "Buitenlandse aardrijkskundige namen in het Nederlands." Retrieved 01-06-2018, from http://namen.taalunie.org/.

NGI (2018a). "Cartoweb.be." Product information. Retrieved 13-05-2018, from http://www.ngi.be/NL/NL1-19-1.shtm.

NGI (2018b). "De toponymie bij het NGI." Retrieved 13-05-2018, from http://www.ngi.be/NL/NL2-11-1.shtm.

NGI (2018c). "Nationaal Geografisch Instituut." Corporate website. Retrieved 13-05-2018, from http://www.ngi.be/NL/NL0.shtm.

Olteanu-Raimond, A.-M., G. Hart, G. Foody, G. Touya, T. Kellenberger and D. Demetriou (2017a). "The scale of VGI in map production: A perspective on European National Mapping Agencies." Transactions in GIS 21(1): pp. 74-90.

Olteanu-Raimond, A.-M., M. Laakso, V. Antoniou, C. Fonte, A. Fonseca, M. Grus, J. Harding, T. Kellenberger, M. Minghini and A. Skopeliti (2017b). VGI in National Mapping Agencies: Experiences and Recommendations. Mapping and the Citizen Sensor. L. See, G. Foody, S. Fritz, et al., Ubiquity Press: pp. 299-326.

Omroep Gelderland (2015), 7 December 2015. "Ludieke actie tegen Achterhoek-borden in de Liemers: 'Hier is niet goed over nagedacht'." Retrieved 01-07-2018, from https://www.omroepgelderland.nl/nieuws/2102505/Ludieke-actie-tegen-Achterhoek-borden-in-de-Liemers-Hier-is-niet-goed-over-nagedacht.

OpenSteetMap (2018). "OpenStreetMap." Platform website. Retrieved 01-06-2018, from https://www.openstreetmap.org/.

Ormeling, F. (2003). Verzameling en vaststelling van de spelling van aardrijkskundige namen in Nederland. Veldnamen: onderzoek en digitalisering. Meertens Instituut.

Ormeling, F. (2009). Standardization of geographical names in the Netherlands. Geographische Namen, Vielfalt und Form. H. Bergmann and P. Jordan. Wien, Praesens Verlag: pp. 55-71.

OS (2012). "Collecting place names with the Maritime and Coastguard Agency." Retrieved 01-06-2018, from https://www.ordnancesurvey.co.uk/blog/2012/12/collecting-place-names-with-the-maritime-and-coastguard-agency/.

OS (2018). "Do you know where to find your Nuncle Dicks or your Deadman's Head?". Retrieved 01-06-2018, from https://www.ordnancesurvey.co.uk/blog/2018/01/know-find-nuncle-dicks-deadmans-head/.

PDOK (2018a). "Nationaal Georegister." Web portal. Retrieved 01-06-2018, from http://www.nationaalgeoregister.nl.

PDOK (2018b). "Publieke Dienstverlening op de Kaart." Web portal. Retrieved 01-06-2018, from www.pdok.nl.

RCTD (2018). "Koninklijke Commissie voor Toponymie en Dialectologie." Corporate website. Retrieved 13-05-2018, from http://www.toponymie-dialectologie.be/index.php?l=nl&p=index-ned.

Rentenaar, R. (1990). Groeten van elders. Plaatsnamen en familienamen als spiegel van onze cultuur. Naarden, Strengholt. ISBN 9789060106969.

Rijksoverheid (2018). "Basisregistratie Personen (BRP)." Product information. Retrieved 01-07-2018, from https://www.rijksoverheid.nl/onderwerpen/privacy-en-persoonsgegevens/basisregistratie-personen-brp.

Rijkswaterstaat (2001). "Handleiding Waterstaatkundig Informatie Systeem, version 0.4." Retrieved 01-06-2018, from https://www.rijkswaterstaat.nl/apps/geoservices/geodata/dmc/wis/productinfo/beschrijvende_documentatie/handlwisshape.doc.

Rijkswaterstaat (2018). "Fairway Information Services." Product information. Retrieved 01-06-2018, from http://www.vaarweginformatie.nl.

Roos, U. (2012). "PlatsNamna." Retrieved 13-05-2018, from https://www.kartverket.no/globalassets/matrikkel/adresse/nordisk-adressesamarbeid/adresseapper/platsnamna_sverige_eng_version.pdf.

RVO (2018). "Natuurschoonwet: landgoed als natuurschoon." Retrieved 01-06-2018, from https://www.rvo.nl/onderwerpen/agrarisch-ondernemen/beschermde-planten-dieren-en-natuur/natuur-en-landschap/natuurschoonwet.

SDFE (2018). "Danske Stednavne." Retrieved 16-05-2018, from http://sdfe.dk/hent-data/danske-stednavne/.

See, L., G. Foody, S. Fritz, P. Mooney, A.-M. Olteanu-Raimond, C. Fonte and V. Antoniou (2017). Mapping and the Citizen Sensor, Ubiquity Press. ISBN 1911529188.

Staat der Nederlanden (2014). Convenant inzake postcodes. Ministerie van Infrastructuur en Milieu. Den Haag, Staatscourant. 2014, Nr. 3779.

Steenbergen, C., W. Reh, S. Nijhuis and M. Puderoijen (2009). De polderatlas van Nederland: pantheon der Lage Landen, Uitg. Thoth. ISBN 9068685090.

Sveriges Riksdag (2018). "Kulturmiljölag ". Retrieved 13-05-2018, from http://www.riksdagen.se/sv/dokument-lagar/dokument/svensk-forfattningssamling/kulturmiljolag-1988950_sfs-1988-950.

swisstopo (2018a). "Geografische Namen der Schweiz." Retrieved 13-05-2018, from https://www.swisstopo.admin.ch/de/wissen-fakten/toponymie.html.

swisstopo (2018b). "swisstopo." Corporate website. Retrieved 13-05-2018, from https://www.swisstopo.admin.ch/.

Sylla, O., D. Antonio and J. Gitau (2018). "The Power of the Social Tenure Domain Model." GIM International 2018(May/June): pp. 27-29.

TomTom (2018). "TomTom." Corporate website. Retrieved 01-06-2018, from https://www.tomtom.com/.

Topografische Dienst (1968). Friese toponiemen. Internal memo 28-10-1968.

Topografische Dienst (1979). Friese toponiemen. Internal memo 24-04-1979.

UNGEGN (2006). Manual for the national standardization of geographical names New York, United Nations. ISBN 9789211614909.

Unie van Waterschappen (2018). "Waterschappen.nl." Corporate website. Retrieved 22-04-2018, from www.waterschappen.nl.

Ushahidi (2018). "Ushahidi." Platform website. Retrieved 01-06-2018, from www.ushahidi.com.

van den Brink, L., H. v. Eekelen and M. Reuvers (2013a). Basisregistratie grootschalige topografie - Gegevenscatalogus IMGeo 2.1.1. Den Haag, Ministerie van Infrastructuur en Milieu.

van den Brink, L., D. Krijtenberg, H. van Eekelen and B. Maessen (2013b). Basisregistratie grootschalige topografie - Gegevenscatalogus BGT 1.1.1. Den Haag, Ministerie van Infrastructuur en Milieu.

wetten.overheid.nl (2018a). "Europees Handvest voor regionale talen of talen van minderheden." Retrieved 10-04-2018, from http://wetten.overheid.nl/BWBV0001223/1998-03-01.

wetten.overheid.nl (2018b). "Wet van 3 mei 1989, houdende regelen met betrekking tot de openbare registers voor registergoederen, alsmede met betrekking tot het kadaster (Kadasterwet)." Retrieved 01-06-2018, from http://wetten.overheid.nl/BWBR0004541/2018-03-31.

wetten.overheid.nl (2018c). "Wet van 15 september 2005, houdende regels over de verplichting om bij de overheidsorganen, bij de uit de openbare kas bekostigde onderwijsinstellingen, alsmede bij de examens waarvoor wettelijke voorschriften zijn vastgesteld, de schrijfwijze van de Nederlandse taal te volgen, waartoe de Nederlandse Taalunie besl ist (Spellingwet)." Retrieved 01-06-2018, from http://wetten.overheid.nl/BWBR0018784/2010-10-10.

Wikimapia (2018). "Wikimapia." Platform website. Retrieved 01-06-2018, from http://wikimapia.org/.

Wikipedia (2018a). "ArcGIS." Encyclopedia article. Retrieved 01-07-2018, from https://en.wikipedia.org/wiki/ArcGIS.

Wikipedia (2018b). "Classification of European Inland Waterways." Encyclopedia article. Retrieved 01-07-2018, from https://en.wikipedia.org/wiki/Classification_of_European_Inland_Waterways.

Wikipedia (2018c). "Crowdsourcing." Encyclopedia article. Retrieved 01-07-2018, from https://en.wikipedia.org/wiki/Crowdsourcing.

Wikipedia (2018d). "Data model." Encyclopedia article. Retrieved 01-07-2018, from https://en.wikipedia.org/wiki/Data_model.

Wikipedia (2018e). "European Charter for Regional or Minority Languages." Encyclopedia article. Retrieved 01-07-2018, from https://en.wikipedia.org/wiki/European_Charter_for_Regional_or_Minority_Languages.

Wikipedia (2018f). "Five Ws." Encyclopedia article. Retrieved 01-06-2018, from https://en.wikipedia.org/wiki/Five_Ws.

Wikipedia (2018g). "MoSCoW method." Encyclopedia article. Retrieved 01-06-2018, from http://en.wikipedia.org/wiki/moscow_method.

Wikipedia (2018h). "West Frisian Language." Encyclopedia article. Retrieved 01-07-2018, from https://en.wikipedia.org/wiki/West_Frisian_language.

Glossary

Term	Explanation
Actueel Hoogtebestand Nederland (AHN)	Digital elevation map of the Netherlands, containing detailed and precise altitude data based on eight elevation measurements per square meter on average (AHN 2018).
Algemene Plaatselijke Verordening (APV)	Local ordinance, decided by the municipality, containing rules and regulations on public order and safety, traffic issues and catering industry affairs, among others (Gemeente Rotterdam 2018).
ArcGIS	GIS software suite with online platform, created by US based company Esri and used for creating maps, compiling and analyzing data, sharing geographic information, and many other applications (Wikipedia 2018a).
Basisregistratie Adressen en Gebouwen (BAG)	Key register, consisting of an addresses registration and a buildings registration. It contains data of all addresses in the Netherlands, with street name, populated place name, number and location; as well as data of all buildings in the Netherlands, including construction year, building size, addressable objects with their usage, and location on the map. The data are maintained by the municipalities, the national database facility is maintained by Kadaster (Kadaster 2018a).
Basisregistratie Grootschalige Topografie (BGT)	Key register, consisting of a very detailed digital topographic data set of the Netherlands with reference scale 1:500 to 1:5,000. The topography is made up of objects for buildings, roads, water, railway lines and vegetation, among other categories; part of them are optional and only from 2020 all attributes must be correct. Data are maintained by a variety of source data holders: municipalities, provinces, water boards, RVO, the Ministry of Defense, Rijkswaterstaat and ProRail. The national database facility is maintained by Kadaster (Kadaster 2018c).
Basisregistratie Personen (BRP)	Key register, consisting of personal data of all inhabitants of the Netherlands and recent emigrants. It contains data on a person's given and family names, sex, national ID number, nationality, marital status, residence, parents, possible children or authority relationships, issued travel documents, right to vote, etc. Data are maintained by the municipalities, the national database facility is maintained by the State Agency for Identity Data (Rijksoverheid 2018).

Basisregistratie Topografie (BRT)	Key register, consisting of digital topographic databases and maps on scale levels 1:10,000 to 1:1,000,000. The topography is vectorized and categorized in 13 feature classes, from roads, water, terrain and buildings to relief, places and administrative areas. Kadaster maintains both the data and the databases in a one-year update cycle (Kadaster 2018e).
CEMT waterway classification	Set of standards for large navigable waterways in Europe, created by the European Conference of Ministers of Transport in 1992. Waterways are classified according to the allowed or possible length, breadth, draught, air draft and tonnage of ships on the waterway (Wikipedia 2018b).
Crowdsourcing	*Portmanteau* word for 'crowd' and 'outsourcing', describing the act of an organization to have an activity performed by a group of individuals rather than by the organization itself; typically an activity that used to be the domain of (governmental) institutions or companies (Wikipedia 2018c).
Damsteegt commission	Formal name: Dutch-Belgian Word List Commission on Geographical Names within the Netherlands. Installed in the 1960s by Dutch government with the task to develop rules and regulations for the standardization of geographical names in the Netherlands. Chaired by Dr. B.C. Damsteegt, it presented its final report in 1973.
Data model	Model that structurizes the way in which data elements in a data set or database are related to each other as well as to real-world objects (Wikipedia 2018d).
Dispersed settlement	Designated area in the countryside with dispersed residential buildings and a certain degree of social cohesion, reflected in a common place name.
Dutch language spelling rules	1804 Siegenbeek spelling, also introduced in 1804 1863 De Vries and Te Winkel spelling, introduced in 1883 1891 Kollewijn spelling, introduced only in South Africa in 1905 1934 Marchant spelling, introduced in 1947 1995 Taalunie spelling, introduced in 1995, updated in 2006
European Charter for Regional or Minority Languages	European treaty, presented by the Council of Europe and ratified by the vast majority of countries in Europe, with the purpose of protecting and promoting historical regional and minority languages in a country (Wikipedia 2018e).

Frisian language	West Germanic language spoken in the Netherlands, mainly in the province of Friesland (Fryslân) where it is the native language of about half of the population. It is recognized by Dutch law as an official language and protected under the European Charter for Regional or Minority Languages (Wikipedia 2018h).
Geographical name	Name of a location or a spatial object, such as a (populated) place, an area, a building, a road or a water body.
IMGeo	Conceptual data model for geographical objects, as applied in the BGT.
ISO standard	International standard published by ISO, with a large degree of authority.
Kadaster Act	Dutch law prescribing the tasks and powers of Kadaster and regulating its activities.
Microtoponym	Geographical name for a small-sized object.
National mapping agency	Governmental agency responsible for the production of topographic maps and geographic information of a country.
PDOK	Platform for the disclosure of governmental geographic data sets in the Netherlands (PDOK 2018b).
Place (in the BRT)	Defined area with buildings used for living, business or recreation. This can be a built-up area or one of its subdivisions, a self-contained industrial area or holiday resort with public roads, a hamlet with a small concentration of buildings, or a dispersed settlement.
Place of residence	Designated area provided with a populated place name, registered in the BAG to be used for addressing.
Populated place	Concentration of buildings with, among other functions, a residential purpose.
Public space	Designated area within a place of residence in the BAG, provided with a name, mainly to be used in addressing. This can be a street name, a water name, a railway name, a construction (bridge, tunnel) name or an area name.
States in the Netherlands	1588-1795 Republic of the Seven United Netherlands 1795-1806 Batavian Republic 1806-1810 Kingdom of Holland 1810-1813 French Empire 1813-1815 Sovereign Principality of the United Netherlands 1815- Kingdom of the Netherlands

Toponymic data	Data related to geographical names.
Type name	Geographical name of descriptive nature, to be distinguished from the proper name of a spatial object. Examples of type names are 'protestant church', 'chemical factory' or 'nature reserve'.
UNGEGN	Expert body of the United Nations dealing with the national and international standardization of geographical names.
Volunteered Geographic Information	Geographic information collected by volunteers.

Appendices

Appendix A: Articles and messages to announce the application and pilot

Article on the Kadaster website

kadaster

home | over het kadaster | pers | english | woordenboek | webwinkel | **inloggen zakelijk**

Particulier | Zakelijk | Nieuws | Contact | Zoek...

home » Nieuws

Help mee: teken zelf de gebiedsgrenzen op de kaart

Nieuwsberichten

RSS

GEPUBLICEERD: 18 FEBRUARI 2015

Het Kadaster doet onderzoek naar crowdsourcing voor de Basisregistratie Topografie. Tot en met 31 maart kunt u via een app zelf de grenzen en namen van gebieden aangeven.

verstuur deze pagina

Op de topografische kaart worden de namen van gebieden genoemd. Namen van bos- duin- en heidegebieden, maar ook streek- en veldnamen en namen van buurtschappen. Maar wat de begrenzing van elk gebied is, wordt in de Basisregistratie Topografie (BRT) nog niet geregistreerd. Ook is niet zeker of de gebiedsnamen die in de BRT zijn opgenomen, nog kloppen. Het Kadaster onderzoekt nu of crowdsourcing werkt voor het inwinnen van deze gegevens. U kunt hieraan meedoen en via een speciale applicatie aangeven wat volgens u de grens én de naam van het gebied is.

Hoe werkt het?
In de applicatie Vlakbijnamen vindt u meer dan 10.000 namen van gebieden. U kunt zelf de begrenzing van een gebied tekenen door op 'bewerken' te klikken. Als u klaar bent met tekenen, vraagt de app u om het type en de naam van het getekende gebied in te voeren. Hebt u alle gegevens ingevoerd? Dan kunt u uw gebiedsvlak terugvinden op de overzichtskaart. Meedoen met het onderzoek gaat het beste vanaf een pc of laptop en is mogelijk tot en met 31 maart 2015.

Onderzoek
De applicatie is onderdeel van het afstudeeronderzoek van Jasper Hogerwerf voor de masteropleiding Geographical Information Management & Applications (GIMA). Het onderzoek richt zich op de mogelijkheden van crowdsourcing bij het inwinnen en bijhouden van geografische naamgegevens in de BRT. Daarnaast moet het onderzoek handvatten bieden voor het inrichten van het werkproces. De in de applicatie ingevoerde gegevens worden nog niet gelijk verwerkt in de datasets van de BRT.

Gerelateerde informatie

Direct regelen

- Contact met het Kadaster
- Aanmeldformulier Mijn Kadaster
- Aanmeldformulier Mijn Kadaster-KLIC

Help us: draw the area boundaries on the map yourself

Published: 18 February 2015

Kadaster conducts research into crowdsourcing for the Key Register of Topography. Until 31 March, you can indicate the boundaries and names of areas yourself via an app.

On topographic maps the names of areas are presented. Names of forest, dune and heath land areas, but also region and field names and names of dispersed settlements. But the boundaries of each area are not yet registered in the Key Register of Topography (BRT). It is also uncertain if the area names included in the BRT are still correct. Kadaster is now investigating whether crowdsourcing works for

the collection of these data. You can take part in this and indicate in a special application what you think is the boundary and the name of the area.

How does it work?

In the application Vlakbijnamen [link to the application Vlakbijnamen] you will find more than 10,000 names of areas. You can draw the boundaries of an area yourself by clicking on 'edit'. When you are finished drawing, the app will ask you to enter the type and name of the drawn area. Have you provided all the information? Then you can find your area polygon on the overview map [link to the application Vlakbijnamen overzicht]. Participating in the research is best from a PC or laptop and is possible until 31 March 2015.

Research

The application is part of the graduation research of Jasper Hogerwerf for the master program Geographical Information Management & Applications (GIMA). The research focuses on the possibilities for crowdsourcing in collecting and maintaining toponymic data in the BRT. In addition, the research should provide methods for organizing the workflow. The data entered in the application are not yet processed in the data sets of the BRT.

Facebook message

Would you like to help me graduate? For Kadaster I investigate if we can update area boundaries in the Key Register of Topography together with you. You can help me by drawing boundaries on the map yourself. [link to article on the Kadaster website] – Jasper Hogerwerf

24 February 2015

Tweet

We conduct research in crowdsourcing for the BRT. Help us: draw the area boundaries on the map yourself [link to article on the Kadaster website]

01:20 19 Febr. 2015

Message posted in the LinkedIn group Basis Registratie Topografie (BRT)

Jasper Hogerwerf
Geo-Information employee at Kadaster

3y

Help mee met inwinnen van gebiedsgrenzen en -namen

Het Kadaster doet onderzoek naar crowdsourcing voor de Basisregistratie Topografie. Tot en met 31 maart kun je via een app zelf de grenzen en namen van gebieden aangeven.

Zowel in TOP10NL als op topografische kaarten zijn namen van gebieden te vinden. Voorbeelden zijn namen van bos-, duin-, en heidegebieden, streek- en veldnamen en namen van buurtschappen. Wat de begrenzing van elk gebied is, wordt in de Basisregistratie Topografie (BRT) nog niet geregistreerd. Ook is niet zeker of de gebiedsnamen die in de BRT zijn opgenomen, nog kloppen. Het Kadaster onderzoekt nu of crowdsourcing werkt voor het inwinnen van deze gegevens. Je kunt hieraan meedoen en via een speciale applicatie aangeven wat volgens jou de grens én de naam van het gebied is.

In de applicatie Vlakbijnamen vind je meer dan 10.000 namen van gebieden:
http://kadata.maps.arcgis.com/apps/Viewer/index.html?appid=d06e9a7272994c70ad485c06c023e81f
Je kunt zelf de begrenzing van een gebied tekenen door op 'bewerken' te klikken. Als je klaar bent met tekenen, vraagt de app om het type en de naam van het getekende gebied in te voeren. Heb je alle gegevens ingevoerd? Dan kun je je gebiedsvlak terugvinden op de overzichtskaart:
http://kadata.maps.arcgis.com/apps/Viewer/index.html?appid=f6ec24e9e79d4d89902be6353a965b15
Meedoen met het onderzoek gaat het beste vanaf een pc of laptop en is mogelijk tot en met 31 maart 2015.

De applicatie is onderdeel van mijn afstudeeronderzoek voor de masteropleiding Geographical Information Management & Applications (GIMA). Het onderzoek richt zich op de mogelijkheden van crowdsourcing bij het inwinnen en bijhouden van geografische naamgegevens in de BRT. Daarnaast moet het onderzoek handvatten bieden voor het inrichten van het werkproces. De in de applicatie ingevoerde gegevens worden nog niet gelijk verwerkt in de datasets van de BRT.

Like Comment | 37 31

Help us with the collection of area boundaries and names

Kadaster conducts research into crowdsourcing for the Key Register of Topography (BRT). Until 31 March, you can indicate the boundaries and names of areas yourself via an app.

Both in TOP10NL and on topographic maps names of areas can be found. Examples are names of forest, dune and heathland areas, region and field names, and names of dispersed settlements. The boundaries of each area are not yet registered in the Key Register of Topography (BRT). It is also uncertain if the area names included in the BRT are still correct. Kadaster is now investigating whether crowdsourcing works for the collection of these data. You can take part in this and indicate in a special application what you think is the boundary and name of the area.

In the application Vlakbijnamen you will find more than 10,000 names of areas: [link to the application *Vlakbijnamen*] You can draw the boundaries of an area yourself by clicking on 'edit'. When you are finished drawing, the app asks you to enter the type and name of the drawn area. Have you provided all the information? Then you can find your area polygon on the overview map: [link to the application *Vlakbijnamen overzicht*] Participating in the research is best from a PC or laptop and is possible until 31 March 2015.

The application is part of my graduation research for the master program Geographical Information Management & Applications (GIMA). The research focuses on the possibilities for crowdsourcing in collecting and maintaining toponymic data in the BRT. In addition, the research should provide methods for organizing the workflow. The data entered in the application are not yet processed in the data sets of the BRT.

19 February 2015

Appendix B: Statistics of the pilot data

Number of polygons with attributes

Layer *Gebiedsvlak* (edited 19 and 20 February 2015):
33 polygons
1 without a name
1 with the name *foutje* (mistake)
31 with a name
10 with a name but without an area type
21 with a name and area type
1 with a name and area type but without an e-mail address
20 with a name, area type and e-mail address

Layer *Vlak* (edited 21 February to 31 March 2015):
365 polygons
24 without a name
6 with the name *test*
335 with a name
8 with a name but without an area type
327 with a name and area type
28 with a name and area type but without an e-mail address
299 with a name, area type and e-mail address

Total for both layers:
398 polygons
25 without a name
6 with the name *test*
1 with the name *foutje* (mistake)
366 with a name
18 with a name but without an area type
348 with a name and area type
29 with a name and area type but without an e-mail address
319 with a name, area type and e-mail address

Number of volunteers and polygons

337 polygons provided with an e-mail address
54 individual e-mail addresses

1 e-mail address with 130 polygons
1 e-mail address with 63 polygons
1 e-mail address with 18 polygons
1 e-mail address with 14 polygons
2 e-mail addresses with 9 polygons
(…)
11 e-mail addresses with 2 polygons
27 e-mail addresses with 1 polygon

Number of large regions and multiple polygons

10 large regions drawn:

- Hoogeland
- Salland
- (De) Veluwe
- Betuwe
- Utrechtse Heuvelrug
- Peel
- Kempen
- Meijerij
- Groene Hart
- West-Friesland

1 large region with multiple polygons:

- Veluwe & De Veluwe (2 polygons)

Location of polygons according to province

Number of polygons per province:

160 Drenthe
76 Fryslân
51 Gelderland
28 Noord-Holland
28 Noord-Brabant
27 Zuid-Holland
26 Utrecht
15 Limburg
9 Overijssel
7 Flevoland
6 Groningen
3 Zeeland

Note: polygons overlapping more than one province were counted for each province they overlap, resulting in a higher number of polygons than the total number of 398 if all the provinces are added up.

Number of polygons according to area type

361 polygons provided with an area type:

143 *streek, veld* (region, field)
87 *bosgebied* (forest area)
34 *heidegebied* (heathland area)
24 *buurtschap* (dispersed settlement)
5 *duingebied* (dunes area)
68 *overig* (other): water names (lakes), islands, park names, nature areas, large regions, farm name, or not explained

Appendix C: List of contributions

Area type	Area name	Remarks
bosgebied	Asserbosch	
heidegebied	Ballöerveld	
bosgebied	Bloemenbos	Het is al een langer bekende naam voor het bos, de langs liggende weg heeft ook de naam bloemenbosweg gekregen. Vroeger verbleven hier ook rontrekkende reizigers.
	De Maten	
bosgebied	De Maten	
buurtschap	goatum	test
overig	Hoogeland	regio
heidegebied	Leusderheide	Militair oefenterrein. Exacte grenzen waarschijnlijk beter bekend bij Min van Defensie.
bosgebied	Noordbargerbos	Ik woon in deze omgeving en ken het bos goed.
overig	Quatre-Bras	Het kruispunt van de N227 en de N224 heeft de bijnaam 'Quatre-Bras'. Een knipoog naar het Napoleontische erfgoed in deze buurt (o.a. Austerlitz). Dit is dus niet echt een gebied, een puntsymbool zou in principe ook volstaan.
streek, veld	Salland	Als historische gemeentegrenzen ook als laag beschikbaar komen kan de streek nauwkeuriger ingetekend worden. De grens Twenterand, Hellendoorn Holten is nog te globaal.
bosgebied	Ubbinkbos	https://www.google.nl/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CCQQFjAA&url=https%3A%2F%2Ftwitter.com%2Fevoosterhout%2Fstatus%2F480378305649332224&ei=um3nVMGvCYGHPb22gJgG&usg=AFQjCNFipV5Eo3J-cHd9A2uk5Hq39wVcxw
heidegebied	Zilvenseheide	
streek, veld	Achter de Koehekken	Naam wordt in Ruinerwold niet gebruikt
streek, veld	Achterste Weide	
heidegebied	Adderveldje	
heidegebied	Aekingerbroek	Tot ca. 1995 grasland (bovenloop Vledder Aa), nu heidegebied
heidegebied	Aekingerzand of Kale Duinen	Ligt in Boswachterij Appelscha (Fr) en klein stuk Bosw. Smilde (Dr)In provincie Friesland; in Drenthe is Boswachterij Smilde (Dr)
overig	Alba plas	
overig	Almeerderzand	
bosgebied	Amsterdamse Bos	
buurtschap	Annabuorren	
streek, veld	Anser hooi- en weilanden	
streek, veld	Anserdennen	onderdeel Nationaal Park Dwingelderveld
streek, veld	Ansermade	
streek, veld	Anserveld	in voormalige gemeente Ruinen
streek, veld	Armveen	
buurtschap	Armweide	
	Bakkerspôle	http://www.warkumserfskip.nl/id66.htm
overig	Bakkerspôle	naam boerderij
bosgebied	Bantam	Gebied dat aangegeven staat als Bantam en wat bereikbaar is met wandelpaden
overig	Bato's wijk	http://www.renkum.nl/Bezoekers/Recreatie/Airborne/Park_Bato_s_wijk
bosgebied	Beatrixpark	
duingebied	bedafse bergen	stuifzand rug
bosgebied	Beekbergerwoud	
streek, veld	Beemster	Werelderfgoed Beemster
	Belmermeer	
	Belmermeer	
buurtschap	Benderse	
streek, veld	Benderse Heide	onderdeel van Dwingeloosche heide en van Dwingelderveld
streek, veld	Bergakkers	Oud bolle akkergebied, deels nog zichtbaar. Nu ook deels nieuwe woonwijk.
streek, veld	Bergboezem	puntobject Bergboezem staat buiten de Bergboezem zelf
bosgebied	Berkenheuvel	Westelijk deel Naturrmonumenten, oostelijk deel Staatsbosbeheer (Bosw. Smilde)
streek, veld	Betuwe	
bosgebied	Bieslandse Bos	
overig	Bijlmermeer	
streek, veld	Binnenesch	ook Havelter binnenesch

streek, veld	Binnenveld	
streek, veld	Bisschopsberg	
streek, veld	Bloeidaal	
streek, veld	Boekesteijn	Recreatiegebied en landgoed.
streek, veld	Boerenmade	
streek, veld	Boerenstroovledder	
overig	Bolswardergat	zijarm van voormalige Makkumermeer, het zgn Tootmeer
overig	Bolswardergat	mogelijk: splitsing van vaarwegen
bosgebied	Boschoord	Maatschappij van Weldadigheid, tevens buurtschap
bosgebied	Boskampbos	
overig	Bossche Broek	
bosgebied	Boswachterij Appelscha	In provincie Friesland; in Drenthe is Boswachterij Smilde
bosgebied	Boswachterij Smilde	Staatsbosbeheer. Westelijk deel (west van Oude Willem) valt hier onder evenals oostelijk deel van Berkenheuvel
bosgebied	Boswachterij Vledderveld	Staatsbosbeheer, voormalige heide
heidegebied	Bouwersveld	van Het Drentse Landschap
overig	Breewar	naam van voormalig eilandje in vroegere Workumermeer
overig	Bréfinne	eilandje
streek, veld	Brinkmaden	
overig	Broekermeer	
bosgebied	Cadettenkamp	
bosgebied	cirkelbos	eerder entry klopt niet. Jw.
bosgebied	Compagnonsbossen	
streek, veld	Compagnonsveld	
bosgebied	Corvers Bosch	Bepaalde perceelgrenzen en wegen zijn buiten beschouwing gelaten
	Dalerveensche Veen	
streek, veld	d'Amelannen	
buurtschap	Daniken	-
bosgebied	Daniken	-
streek, veld	Darperesch	
buurtschap	De Boerschop	De oorsprong van het dorp Luttenberg. Op oude kaarten wordt het gebied als 't Loo bron voor huidige naam: http://www.pbluttenberg.nl/index.php?section=10&page=29 Als vlak ingetekend exacte omtrek nog na te gaan.
overig	De Braak	
streek, veld	De Broeken	
streek, veld	De Doeze	
	De Dreven	
	De Eglantier	
	De Eglantier	
streek, veld	De Eng	vergelijkbaar met begrenzing aangegeven op http://www.wageningseeng.nl/index.cfm
streek, veld	De Eng	cultuurhistorisch belangrijk
streek, veld	De Esch	
streek, veld	De Esch	wordt ook Anseresch genoemd
	De Gaarden	
overig	De Geeuw	voormalige plas, drassige plek
buurtschap	De Haese	-
overig	De Heijmaten	bron: Bonnekaart
streek, veld	De Heinis	
overig	De Hoeve Slagen	bron: Bonnekaart
	De Hoeven	
streek, veld	De Holten	
streek, veld	De Hoorns	
streek, veld	De Horsten	
	De Horsten	
bosgebied	De Kleine Zaag	
overig	De Kolken (Grote Kolk)	zij armen van het vroegere Workumermeer
overig	De Kolken (Kleine Kolk)	zij armen van het vroegere Workumermeer
overig	De Kolken (Kleine Kolk)	zij armen van het vroegere Workumermeer
overig	De Kolken (Kleine Kolk)	zij armen van het vroegere Workumermeer
streek, veld	De Koornwaard	
streek, veld	De Kraats	

overig	De Krite	
overig	De Krite	
streek, veld	De Laken	Top. krt 1850
bosgebied	De Loet	
overig	De Marren	verwijzing naar voormalig Henshuistermeer?
buurtschap	De Meern	
	De Meinweg	
	De Nes	
overig	De Nollen	
overig	De Nollen	
	De Pasmaten	bron: Bonnekaart
overig	De Petten	
streek, veld	De Pine	polder, nu geheel in beheer als weidevogelreservaat
streek, veld	De Schammer	
bosgebied	De Slotplaats	
heidegebied	De Stoevert	voormalig stuifzandgebied, recent deels bos gekapt
heidegebied	De Stoevert	voormalig stuifzandgebied, recent deels bos gekapt
	De Ungels	bron: Bonnekaart
overig	De Ungels	bron: Bonnekaart
bosgebied	De Veluwe	Zo ongeveer?
buurtschap	De Wal	
overig	De Wolvetinte	
overig	De Worp	
overig	De Worp	
overig	De Zaag	gemengd natuur/industrie/waterkering
streek, veld	Deekland	
bosgebied	Delftse Hout	Aangenomen dat camping de Delfse Hout bij het bosgebied hoord. Kan ook een apart gebied zijn.
duingebied	Derde Duintjes	
streek, veld	Dieverveld	thans onderdeel van Bosw. Smilde
bosgebied	Dijkgat Bos	
streek, veld	Doldersummer	Zomerhuisjesgebied
streek, veld	Doldersummeresch	Schrijfwijze met dubbel m
streek, veld	Doldersummermade	beekdal Vledder Aa (in voormalige gemeente Vledder)
heidegebied	Doldersummerveld	Natuurgebied van Het Drentse Landschap
overig	Domeinenput	
heidegebied	Drentse Broek	vanaf 1990 in groot deel bos verwijders
heidegebied	Drieberg	Er liggen hier drie grafheuvels op een rij, wat waarschijnlijk de oorsprong van de naam is.
bosgebied	Driehoeksbos	
bosgebied	Driepoel	-
heidegebied	Duurswouderheide	
heidegebied	Dwingeloosche Heide	Deel van Nationaal Park in eigendom van Natuurmonumenten
bosgebied	Edesche Bos	zie https://www.ede.nl/fileadmin/_processed_/csm_bossen_871e639d8e.jpg
streek, veld	Eesveensche Hooilanden	
streek, veld	Emmer Hooilanden	
streek, veld	Emmermaden	
streek, veld	Emmerveld	
bosgebied	Ermerveen	Is geen heidegebied
bosgebied	Etsbergerbos	
streek, veld	Ettelte	De soms gebruikte naam Artelte is volgens mij niet juist
streek, veld	Eursingerbinnenesch	
bosgebied	Flietsterbosk	jonge bosaanplant op klei
bosgebied	Formerumerbos	
overig	foutje	
overig	Froskepôlle	
bosgebied	Galgenberg	
bosgebied	Galgeveld	
overig	Goudse Hout	parklandschap met waterpartijen
overig	Greate Griene	eilandje
bosgebied	Grikelân en Turkije	http://www.itfryskegea.nl/Natuurgebied/Grikelan-en-Turkije/
streek, veld	Groene Hart	
streek, veld	Groenlanden	Naam wordt volgens niet (meer) gebruikt hier

buurtschap	Haesselderveld	-
heidegebied	Havelterberg	heide- en bosgebied
streek, veld	Heezenesch	
duingebied	Helmpollen of Vierde Duintjes	
overig	Helpoortspoel	voormalige poel, reeds lang verland en onherkenbaar in het landschap. Helpoortspoel is vermoedelijk een verbastering van 'Healpoartspoel' (Halvepoortspoel). Ook als Holpoortspoel.
streek, veld	Hennehorst	in voormalige gemeente Diever
streek, veld	Henshuisterveld	buurtschap heet tegenwoordig Jinshúzen. toponiem wordt Jinshústerfjild?
bosgebied	Hertenkamp	
heidegebied	Hertenkamp	Onderdeel van Berkenheuvel van Natuurmonumenten; was grotendeels bos en cultuurland, thans heidegebied
bosgebied	Het Hoge Bergsche Bos	
overig	Het Joo	voormalige plas, drassige plek
bosgebied	Het Lage Bergsche Bos	
bosgebied	Het Leesten	
overig	Het oude Hof	http://onh.nl/nl-NL/verhaal/1877/het-oude-hof-te-bergen-1
bosgebied	Het Platte	
overig	Het Rondeel	
streek, veld	Het Schier	
streek, veld	Hezenesch	ook Hezeresch geschreven
overig	Hichtepoel	voormalige poel
bosgebied	Hoekenbrink	voormalig heide-/stuifzandgebied
heidegebied	Hoge Veluwe	Bos- en heidegebied, Nationaal park
buurtschap	Holtinge	mogelijk onderdeel van Uffelterveen
heidegebied	Holtingerveld	heide- en bosgebied. Natura2000-begrenzing; voorheen Havelte-oost genoemd
bosgebied	Holtingerveld	
bosgebied	Holtingerzand	voormalig stuifzandgebied
streek, veld	Hooge Klei	
streek, veld	Hooge Stukken	in voormalige gemeente Diever
streek, veld	Horrelveen	
bosgebied	Hulsebosch	
overig	Hynstewerp	voormalig eilandje, vastgegroeid aan grote eiland
streek, veld	It Galgelân	
overig	It Klokhûs	kerkhof met klokkenstoel (It Klokhûs)
buurtschap	Janskamperpark	-
bosgebied	Jolderenbos	
overig	Kakeshoek	kenmerkende hoek gevormd door de splitsing Van Panhuyskanaal - Makkumer Feart
streek, veld	Kalterbroeken	tevens naam nieuwe woonwijk
streek, veld	Kampen	
	Kanaalpark	
bosgebied	Kapellebos	
streek, veld	Kattemade	in voormalige gemeente Diever
streek, veld	Kempen	
heidegebied	Klaasbergplassen	
streek, veld	Klompenmakersweide	
bosgebied	Kocherbos	geen
heidegebied	Koelingsveld	van Het Drentse Landschap
overig	Koemarkt	
heidegebied	Kolonieveen	mogelijk onderdeel van Uffelterveen
bosgebied	Konijnenbosch	
streek, veld	Kop Bloksloot	
duingebied	Korte Duinen	
bosgebied	Kralingse Bos	
streek, veld	Kraloëresch	
heidegebied	Kraloerheide	Deel van Nationaal Park Dwingelderveld in eigendom van Staatsbosbeheer
streek, veld	Lage Veld	
streek, veld	Land van juffrouw Ali	
bosgebied	Landgoed Ooster- en Westerzand	
bosgebied	Landgoed Vledderhof	van Het Drentse Landschap
streek, veld	Landtong	
duingebied	Lange Duinen	

streek, veld	Lange Warren	
overig	Larixhof	
bosgebied	Liesbos	
streek, veld	Looakkers	
overig	Luizenburg	voormalige plas
overig	Lytse Griene	eilandje
overig	Lytssân	voormalig eilandje, vastgegroeid aan het eilandje Bréfinne
streek, veld	Maasland	
streek, veld	Makkumernoordwaard	natuurgebied
	Matenhoek	
	Matenveld	
streek, veld	Meijerij	
streek, veld	Meskenwiersterfjild	
overig	Monnikenmeer	
bosgebied	Muiderzand	
buurtschap	Müllerpier	
streek, veld	Munnikenbosch	
streek, veld	Muzeplak	
bosgebied	Nevelhorst	Recreatiegebied
overig	Nienoord	
buurtschap	Nieuw Doldersum	Zomerhuisjesgebied
streek, veld	Nieuwe Landen	
heidegebied	Nijensleekerveld	Het Drentse Landschap; restant heide
streek, veld	Nijensleekerveld	grotendeels voormalige heide
bosgebied	Nimmerdor	
heidegebied	Noord Ginkel	Puntlocatie staat te veel naar het oosten
streek, veld	Noordbargeresch	
streek, veld	Noordenveld	ontgonnen heide, thans weer natuurgebied; onderdeel Nationaal Park Dwingelderveld
streek, veld	Noorderesch	
streek, veld	Noordmaden	
bosgebied	Norgerholt	
bosgebied	Nuilerbosch	
streek, veld	Oldendieverveld	
bosgebied	Oosterbos	
streek, veld	Oosteresch	
streek, veld	Oosterveld	
bosgebied	Oosterzand	
streek, veld	Oostzanerveld	
streek, veld	Ootmaan	
overig	Osdorp	
streek, veld	Ottema-Wiersma reservaat	
overig	Oude Kerkhof	de benaming verwijst naar het oude kerkhof van het verdronken 'oude dorp' Elahuizen.
streek, veld	Oude Nieuwe Landen	
streek, veld	Oude Willem	Cultuurland/buurtschap. Drents deel (in ca 2000) grotendeels ingericht als (nat) natuurgebied
streek, veld	Oude Zoek	
buurtschap	Oud-Geleen	-
bosgebied	Overbos	
buurtschap	Overvecht Noord	http://www.utrecht.nl/images/DWS/Overvecht/foto/plattegrond_overvecht_2010.jpg.jpg
buurtschap	Overvecht Zuid	http://www.utrecht.nl/images/DWS/Overvecht/foto/plattegrond_overvecht_2010.jpg.jpg
overig	Parnassiapark	
buurtschap	Patersveld	-
streek, veld	Peel	
overig	PEN-eiland, alias Diemer vijfhoek	http://nl.wikipedia.org/wiki/PEN-eiland
streek, veld	Plak van 15	
bosgebied	Plantsoen	zie bonnekaarten
overig	Plaswijk	
streek, veld	Polder Ten Cate	Ten Cate met een C; thans natuurgebied Staatsbosbeheer
streek, veld	Purmer	

streek, veld	Reest	Ook 'Op Reest'; onderdeel Landgoed Rheebruggen
heidegebied	Regte Heide	begrenzing van Natura 2000 gebied Regte Heide en Riels Laag
streek, veld	Rietschar	
streek, veld	Rijk van Nijmegen	
bosgebied	Robbenoordbos	
heidegebied	Ronde Wei	
bosgebied	Ruigeplaatbos	
bosgebied	Rysterbosk	
streek, veld	Schieresch	
bosgebied	Schietbaanbos	
bosgebied	Schillenveen	
bosgebied	Schillenveen	
bosgebied	Schollebos	
streek, veld	Sippen-finnen	natuurgebied
heidegebied	Smitsveen	Ander Smitsveen
heidegebied	Smitsveen	Ander Smitsveen dan zuidelijker gelegen in Spaarbankbosch
heidegebied	Spaarbankbosch	vrijwel geheel gekapt
streek, veld	Spijk	Ook 'Op Spijk' genoemd; sloot door gebied heet Spijksloot
overig	Stadspark	
bosgebied	Staelduinse bos	
bosgebied	Sterrebosch	
streek, veld	Stoenckherne	natuurgebied
bosgebied	Stormpolder Vloedbos	
overig	Subêd	"Subêd = de verbreding van de Moark ten noorden van de Canterlandse brug"
bosgebied	't donders goet	
bosgebied	't Oude Bosch	
streek, veld	Ten Eysden	-
buurtschap	test	test
bosgebied	test	geen
bosgebied	test	geen
bosgebied	test	test
bosgebied	test	test
buurtschap	test	test
streek, veld	Turfvenen	ook Turfveentjes genoemd
streek, veld	Uffeltermade	
heidegebied	Uffelterveen	
overig	Utrechtse Heuvelrug	
bosgebied	Vaartsluitbos	
streek, veld	Valtherzand	
overig	Van Coehoornbos	
streek, veld	Veenhuizerlanden	beekdal Vledder Aa (in voormalige gemeente Diever)
streek, veld	Veenhuizermade	beekdal Vledder Aa (in voormalige gemeente Diever)
streek, veld	Veldhuizerlanden	beekdal Vledder Aa (in voormalige gemeente Diever)
streek, veld	Veldhunten	
streek, veld	Veluwe	bron: http://reizen-en-recreatie.infonu.nl/binnenland/63853-vakantie-op-de-veluwe.html
bosgebied	Venebos	
streek, veld	Vlasakkers	
streek, veld	Vlasveen	in Vledderhof
streek, veld	Vledderech	
streek, veld	Vledderlanden	ook Vledder Stukken genoemd
streek, veld	Vleddermade	beekdal Vledder Aa (in voormalige gemeente Vledder); ook Vledder Ma genoemd
streek, veld	Vledders	
streek, veld	Vledderveld	voormalige heide
streek, veld	Vledderveld	voormalige heide
streek, veld	Voorlanden	
streek, veld	Voorr de Koehekken	Naam wordt in Ruinerwold niet gebruikt
buurtschap	Vrachelen	Wijk 07 Vrachelen vanuit CBS data zal worden uitgebreid met de komst van de nieuw woonwijk de contreie (bouwplannen vrachelen 4 en vrachelen 5), zie structuurplan http://goo.gl/u7P7Rn
streek, veld	Vrije Grazen	
streek, veld	Vrouwenveld	laag en relatief nat gebied

streek, veld	Wapser Noorderveld	Cultuurland (voorheen heide). Na ontginning heide is naam Wapserveld gegeven aan noordelijk gebied (van Natuurmonumenten).
streek, veld	Wapserveensche Landen	
overig	Wapserveense Petgaten	Moerasgebied
heidegebied	Wapserveld	Onderdeel van Ber
streek, veld	Wapserzand	voormalig stuifzandgebied, nu bos; onderdeel Berkenheuvel Natuurmonumenten
buurtschap	Wateren	
streek, veld	Waterland	
bosgebied	Waterlandse bos	
buurtschap	Welten	
overig	Westelijke Mijnstreek	grote streek
streek, veld	Westerechesch	thans deels bebouwing
streek, veld	Westerveld	
bosgebied	Westerzand	
streek, veld	West-Friesland	
overig	Wijbepoel	verdwenen laagte/poel
streek, veld	Wiltenkamp	
overig	Wippolder	
streek, veld	Witteltermade	in voormalige gemeente Diever
streek, veld	Witteltervel d	Restand groter heidegebied (Natuurmonumenten)
streek, veld	Wittesheuvel	
bosgebied	Witteveen	
overig	Wonserweerstal	afgegraven terp. http://www.hwwunseradiel.nl/archief/WON001/WEB/dehistoriegaatdoorheteigendorp.html
heidegebied	Zilvense Heide	hgeiu
heidegebied	zilvense heide	
heidegebied	Zuid Ginkel	
streek, veld	Zuid Wapserlanden	
overig	Zuiderpark	
streek, veld	Zuiderveld	voormalig heidegebied
buurtschap	Zundertsche Schijf	
streek, veld	Zure Venen	ook Zoere Venen, van Staatsbosbeheer
streek, veld	Zuurlanderesch	
overig		
bosgebied		
streek, veld		
streek, veld		
bosgebied		
bosgebied		