

The updating process of a National Atlas in a GDI environment: the role of atlas editors

Maia Zumbulidze
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by

Maia Zumbulidze

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Thesis Assessment Board:

Chair: Prof.Dr. M.J. Kraak

External examiner: Prof. Dr. F.J. Ormeling

Supervisor: B.J. Köbben MSc

Second supervisor: Prof.Dr. M.J. Kraak



**INTERNATIONAL INSTITUTE FOR GEO-INFORMATION SCIENCE AND EARTH OBSERVATION
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Abstract

A National atlas is a collection of maps with a narrative function. National Atlas maps represent spatial datasets that characterize a country. An important aspect of a National Atlas is the ability for maps comparison. A National Atlas can provide an alternative access to a Geospatial Data Infrastructure (GDI), this means that National Atlas maps can use geospatial data from different sources available through GDI. This research will be based on the current prototype of the Dutch National Atlas (3rd edition), its functions have been integrated with Geo-Webservices that make up a GDI. The current prototype doesn't have any function of the updating process. The main goal of this research is to perform an update process of National atlas maps in a GDI environment. For this reason some functions for the updating process have been added considering National Atlas map design and GDI constrains. Furthermore we set up a conceptual design of the updating process that will include the components required for the updating process.

With the aim to maintain well designed maps after updating process of National Atlas maps, the main objective of this research is to establish the tasks of a National Atlas Bureau in a (semi) automatic update process of National atlas maps in a GDI. A (semi) automatic update workflow has been designed using the scenario's for different types of maps and different types of data changes. Based on the scenario's we got a clear picture, where in the updating process a human interaction is needed and which part of the updating process can be done fully automatically.

As a result we present a (semi) automatic update workflow and a conceptual design of the updating process; Logical and physical design of the updating process. According to the results of this research, we can say that it is likely to have an update process as automate as possible, but there are some cases in an update process that needs a human interaction. This process is flexible, the roles can be changed between an automatic part of system and a human part of National Atlas Bureau.

Keywords

National Atlas, Geospatial Data Infrastructure (GDI), Geo-Webservices, map design, update process, metadata

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List of acronyms

| | |
|------|--|
| CBS | Centraal Bureau voor de Statistiek (otherwise known as Statistics Netherlands) |
| CSW | Catalog Service Web |
| GDI | Geospatial Data Infrastructure |
| GDSC | Geospatial Data Service Centre |
| GML | Geography Markup Language |
| OGC | Open Geospatial Consortium |
| OWS | Open Web Services |
| SOA | Service-Oriented Architecture |
| SVG | Scalable Vector Graphics |
| WCS | Web Coverage Service |
| WFS | Web Feature Service |
| WMS | Web Map Service |
| WPS | Web Processing Service |
| XML | Extensible Markup Language |

1. Introduction

1.1. Motivation and problem statement

A National Atlas presents a synthesis of the spatial knowledge that characterizes a country (Ormeling, 2008). It represents spatial datasets by maps with narrative function. A National Atlas can be considered as a tool for exploration, since atlas maps comparison is possible. This means that all data is processed to be comparable: The same scale and the same degree of generalization are applied (Ormeling, 2008). Considering these aspects is important for comparing maps in the National Atlas and also important to get useful information from a comparison. For atlas maps comparison there are: Temporal comparison (specific themes at different times), geographical comparison (same theme at different areas), and thematic comparison (different themes at the same are) (Ormeling, 2008). National Atlas maps could be used by users using ready-made maps and also the users who need to consult and explore geospatial information (Kraak, et al., 2009).

The National Atlas maps have a function to provide an alternative interactive and dynamic access to Geospatial Data Infrastructure (GDI) (Aditya, et al.,2007) , it means that geospatial data from different sources available through GDI can be used by the National Atlas maps. The users can access different type of geospatial datasets using the National Atlas maps, the datasets can be made comparable, and the atlas can function as a decision making tool (Kraak, et al., 2009).

The principle “collect once, use many times” is very much relevant to the Geospatial Data Infrastructure. Geospatial Data Infrastructures (GDIs) have been defined by Groot and McLaughlin (2000) as “a set of institutional, technical and economical arrangement , to enhance the availability (access and use) for correct, up-to-date, fit-for-purpose and integrated geo-information, timely and at an affordable price, with the goals to support decision making processes related to countries’ sustainable development”. It is obvious that there is a need to access and share geospatial information considering some standards that can be done using GDI. It allows sharing data from different sources and helps users to save resources, time and efforts to enquire new datasets (Rajabifard , et al.,2001).A GDI typically consists of Geo-Webservices, some of which are developed and owned by commercial companies (i.e. Yahoo maps, MSN Virtual Earth, MultiMap), and others are part of the Open Web Services (OWS), standardised by the Open GeoSpatial Consortium (OGC) (Kraak, et al., 2009). For the whole spatial data process there are OWS specifications defined. For example, the Catalog Service Web (CSW) provides metadata specifications; the Web Coverage Service (WCS) and Web Feature Service (WFS) for raster and vector data delivery respectively; the Web Processing Service (WPS) for spatial data processing; the Web Map Service (WMS) for data display. Often WMS are used to deliver the maps to the users, but according to (Kraak, et al., 2009) data services (e.g., WFS, WCS) should be used by the National Atlas which will combine and portray data for example from GDI WFS

sources in a cartographically sound client-side application. The reason for this is that WMS is a fixed layout, but we are interested in making a specific National Atlas design template and we should start from a row data. There is the data integration component and the mapping component located on an atlas server. The data integration component is used to integrate data from different sources and re-refresh existing spatial data. The mapping component is used to design and visualize correctly existing data layers (Kraak, et al., 2009).

It is important to mention that there are three main principles in the National Atlas interface development process: A uniform interface; According the design of the National Atlas, it could be used by different group of users; The National Atlas should be meet users' needs (Kraak, et al., 2009).

An update process of the National Atlas is important in GDI environment. Since the specific atlas functions have been integrated with Geo-Webservices, the newest data can be used in the National Atlas. There are some aspects, which should be considered in the updating process. For example, the update process (depending on the data) may change class boundaries and since the similar classification methods are used in the National Atlas, this may result in changing map legend and map design.

This research will be based on the current prototype of the Dutch National Atlas (3rd edition). It doesn't have any functions of the updating process. For this reason some functions for the updating process will be added considering National Atlas map design and GDI constrains. In this research we will concentrate on National Atlas data metadata and GDI data metadata, since metadata plays a significant role in the updating process of National Atlas maps in a GDI environment. Metadata describes how and when and by whom a particular set of data was collected, and how the data is formatted; well structured metadata is more easily discoverable (URL6). Based on the metadata available, National Atlas maps will be updated. Furthermore we will set up a conceptual design of the updating process that will include the components required for the updating process. Also a (semi) automatic update workflow will be designed using the scenario's for different types of maps and different types of data changes. Based on the scenario's we will get a clear picture, where in the updating process a human interaction is needed and which part of the updating process can be done fully automatically.

Since we believe that the whole updating process can't be fully automated and a human interaction is necessary for maintenance well designed maps, this research will determine the functions of National Atlas Bureau, the possible role of a National Atlas Bureau with staff in an update process workflow. The National Atlas Bureau is responsible for the quality of the atlas, this means that the National Atlas cannot function without support of an atlas editors (Kraak, et al., 2009). Staff of an atlas bureau would be able to provide well-designed and up-to-date maps (Aditya, et al., 2007). The atlas editors should be aware of the new geospatial information available by national data providers (Kraak, et al., 2009). Also the National Atlas Bureau is responsible to maintain National Atlas metadata, which is very important in the updating process.

1.2. Objectives and research questions

The main objective of this research is to establish the tasks of a National Atlas Bureau in a (semi) automatic update process of National Atlas maps in Geospatial Data Infrastructure (GDI). There are three sub objectives that could be attained by answering the research questions:

- Determine the possible role of a National Atlas Bureau.
- Describe the possibilities for a (semi) automatic update process of National Atlas maps from GDI data.
- Design an update process workflow and specifically the role of a National Atlas Bureau in it.

Determine the possible role of a National Atlas Bureau: This sub objective can be reached by answering the following research questions:

- What is a National Atlas?
- What is a National Atlas Bureau?
- How the datasets available from national data providers can be visualized according to design templates?

Describe the possibilities for a (semi) automatic update process of National Atlas maps from GDI data: To attain this sub objective the following research questions should be answered:

- What is a Geospatial Data Infrastructure (GDI)?
- What is a semi automatic update process flow?
- How will design templates fit in an update process?
- How does this work in terms of technical (e.g. Geo-Webservices) aspect?

Design an update process workflow and specifically the role of National Atlas Bureau in it: This sub objective is related to the following research questions:

- How does the update process work for the National Atlas in a GDI?
- What are the possible problems and limitations of such an update process?
- How can an update process influence a map design (for example, how can symbologies, similar class boundaries and legend colours be maintained through the update process)?

1.3. Methods

To answer the research questions the following methods will be used. Figure 1.1 shows methodology of the research. The first task will be literature review on concept of National Atlas, National Atlas bureau, concept of Geospatial Data Infrastructure (GDI). Before a (semi) automatic update process flow will be designed, we will examine concept of National Atlas and GDI, examine the role of National Atlas Bureau, we will investigate current prototype of the Dutch National Atlas (3rd edition).

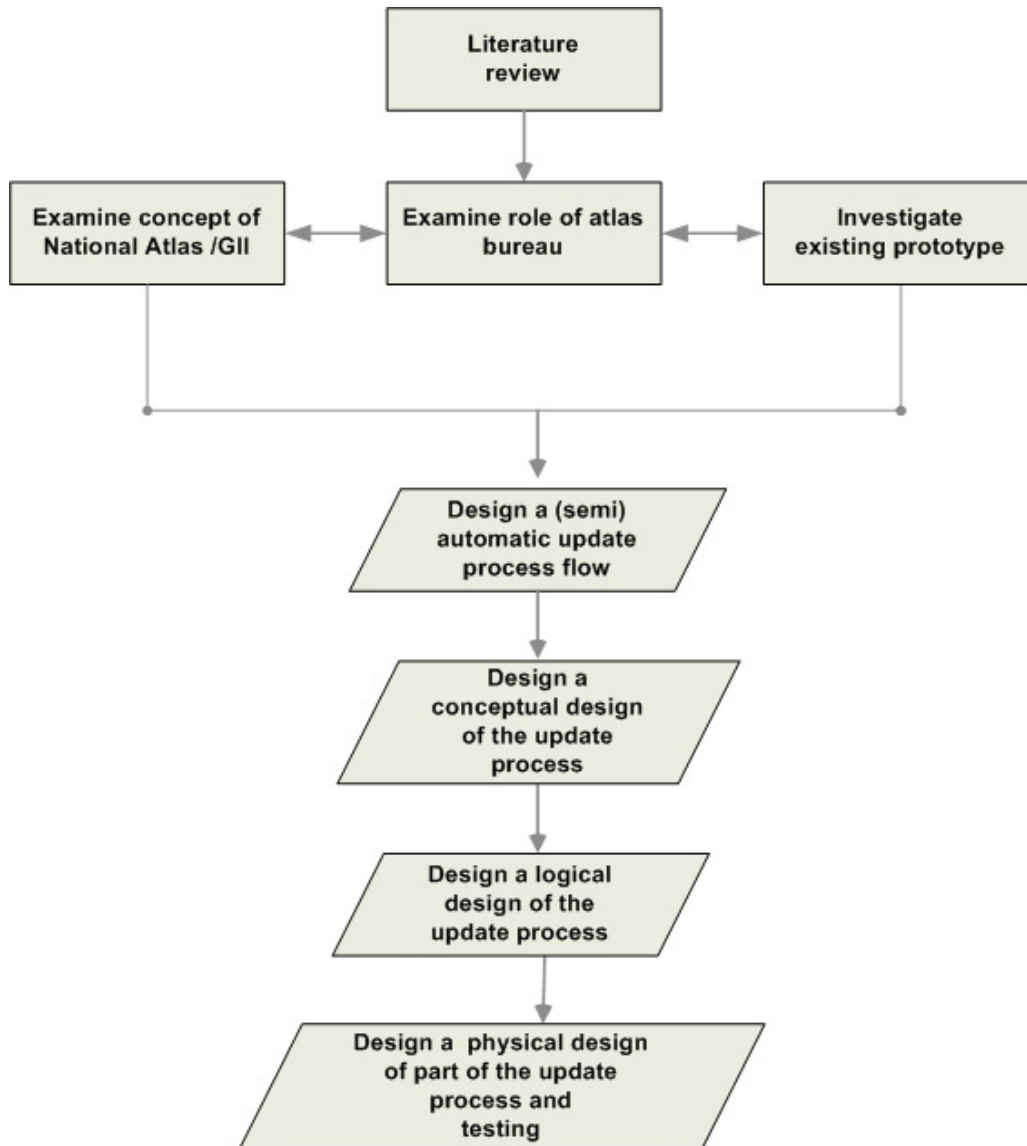


Figure 1.1 Methodology of the research

Next, we will design a (semi)automatic update process workflow using the scenario's for different map types and different types of data changes. We will set up a conceptual design of the update process for an ideal situation and for the practical case. Then a logical design of the update process will be designed by us. Next, we will perform limited testing of the conceptual and logical design by actually implementing a physical design using the scenario 3 for the updating process and testing it.

1.4. Thesis structure

This research will be composed of seven chapters. In the next chapter we will present literature review; we will introduce the concept of an atlas in general and specifically concept of National Atlas, its functionality and structures. We will discuss about the role and tasks of

a National Atlas Bureau with staff. Concepts and different methods of map design will be introduced and we will talk specifically about National Atlas maps design and production. A second part of literature review will be started by introducing the concept of Geospatial Data Infrastructure (GDI); Geo-Webservices and geo-portals as part of GDI will be introduced. We will discuss about National Atlas as a portal, National Atlas information structure and metadata visualization.

In chapter 3 will present a (semi) automatic update process workflow. Firstly we will describe map design process; automated map design and updating process based on Cartographic Design Expert System. This chapter will include scenario's based on a (semi) automatic update process flow for different map types. In chapter 4, we start by presenting the current prototype of the Dutch National Atlas (3rd edition), its design strategies and technical implementation. We will set up a conceptual design of the updating process for an ideal situation and for the practical case (based on the current prototype). Also we will introduce an archival system of National Atlas maps. The next chapter is the implementation; a server-side scripting language will be used for the implementation of part of the logical design. The following chapter will present results of the research. In chapter 7, we will conclude our work and give the recommendations for the future work.

2. Literature review

2.1. Introduction

In order to answer the research questions have been set and to expand the knowledge about concepts that are relevant to this research the following topics are discussed: concept of Atlases, concept of National Atlases, its structures and functionality, the role of National Atlas bureau, concept and methods of map design, National Atlas maps design and production, concept of Geospatial Data Infrastructure (GDI), Geo-Webservices, geo-portals as part of GDI, the National Atlas as portals, National Atlas information structure, metadata visualization.

2.2. Concept of Atlas

Atlases are generally considered a higher form of cartography since there is both an extra planning and an extra structural dimension in their production (Kraak, et al., 2003). An atlas is a communication device that speaks primarily through maps (Buckley, 2003). The concept was first elaborated by Ortelius and Mercator in the 1570s as an optimal way of presenting and comparing geographical information (Ormeling, 1995). The concept is still valid, because it has strength in comparing situations (Ormeling, 1995).

An atlas consists of various data sets, which are comparable. There is a number of access mechanisms, that are used for such comparisons (e.g. a geographical names index, map index sheets, and a general legend) (Ormeling, 1997).

For a better understating of the atlas concept, a number of atlas concepts are given by Ormeling (1997):

- The atlas as a superior storage device
- The atlas as a visualization device
- The atlas as a comparison machine
- The atlas as a conscious combination of maps
- The atlas as an isolating device
- The atlas as a collection of true maps
- The atlas as an exploration device
- The atlas as an interface with an underlying database

According to this list, so many different ways of using atlases we have to take into account, which is not so easy. Not all of these concepts will be treated in this research in detail.

2.2.1. National Atlases

A National Atlas generally includes maps of a great variety of subjects (van Elzakker, 1984). The National Atlases pretend to portray all aspects of the physical, social, economic and cultural life (Ormeling Sr, 1979). All the geographical information presented by National Atlases is relevant to the country.

A National Atlas is a collection of maps with a narrative function. The National atlas has several important aspects. All information is rendered at the same scale, the same level of generalization is applied, and similar classification methods are used (Kraak, et al., 2009). Based on these characteristics National Atlas maps comparison is possible. According to Ormeling (2008) for atlas maps comparison there are: temporal comparison (specific themes at different times), geographical comparison (same theme at different areas), and thematic comparison (different themes at the same area).

The first National Atlas has been created in 1899 in Finland, followed by Canada in 1906 and by the other countries: France, Belgium, Hungary, Italy, Netherlands, Norway, Sweden, Switzerland and etc. The Atlas of the Netherlands has pioneered the integration of new geographic concepts and new presentation techniques (the second edition, published 1989-1995) (Freitag, 1997).

Since the 1990s, there is a movement from paper to digital atlas, to atlas information systems. Paper National Atlases were the first to be developed into electronic National Atlas information systems, and reference atlases followed (Kraak, et al., 2003). Book and DVD type of atlases are closed systems as compared with electronic National Atlas information systems and they are current at the time of publication (Kraak, et al., 2007). National Atlases disseminated through the internet have more functions than book and DVD type of atlases (e.g. as a geo-portal, as well as an integrated part of Geospatial Data Infrastructure (GDI)).

The production of electronic atlases is the result of the development of hardware and software components. It requires a specific electronic environment (Freitag, 1997). There are three types of electronic atlases: View-only electronic atlases; Interactive electronic atlases; Analytical electronic atlases (Kraak, et al., 2003). The Atlas of Canada was one of the first examples of a national web atlas, with Sweden and the US as other early examples (Aditya, 2007). Aditya (2007) states, that this development has its advantages, but at the time there are some challenges for the National Atlas maps design.

2.2.2. National Atlas functionality and structures

A National Atlas has some predetermined functions, e.g. to provide a prestige publication for displaying national pride that covers national unity and identity; maps for physical and economic planning and policy; tools for problem solving; stimulating interests in both novices and experts; a sound basis for further cartographic work (Freitag, 1997; Aditya, 2007). In different countries there are various functions of National Atlases, e.g. in Japan a National Atlas is considered as real reference in relation to business programs and market surveys; In Sweden as prestige publications, demonstrating geographical and cartographic know-how; In Hungary the National atlas function is to assist map users to become acquainted with new

types of cartographic presentation. In general, the function of National Atlases is considered as systems of information, that is easy to find and accessible to everybody (Ormeling, 1997).

There are two aspects of the structure of National Atlas: maps arrangement (based on area and scale emphasis) and thematic sequence (Ormeling, 1997). National Atlases attempt analysis and interpretation using map comparison (Freitag, 1997). Since a National Atlas can be used for a spatial comparison, it can be delivered as spatial data organizer, visualization device, exploration device (Ormeling, 1997). As mentioned above some countries (e.g. Switzerland, Sweden, USA, Canada, the Netherlands) have the online National Atlases and some of them (The National Atlas of the United States of America; The Atlas of Canada; The Dutch National Atlas) have services to access to Geospatial Data Infrastructure (GDI).

The online National Atlas maps use datasets, and have access to metadata. It is important to link metadata to the related maps. There is a possibility to register a metadata to more than one map, if it fits into storyline designed (Aditya, 2004). Figure 2.1 shows the linkage between the metadata and the related maps.

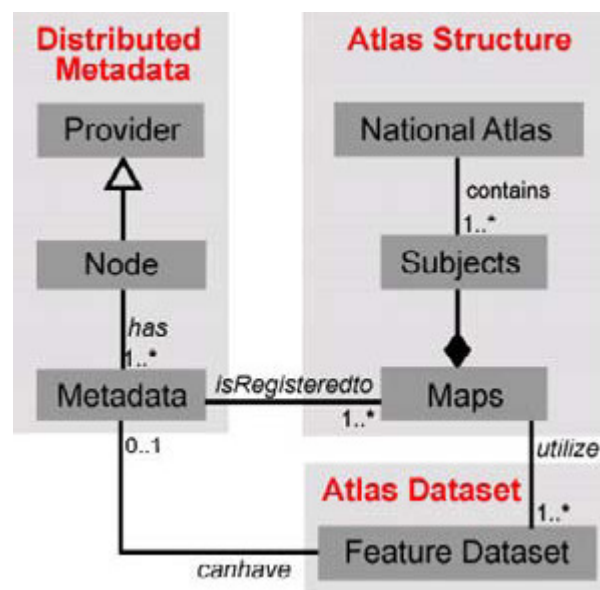


Figure 2.1 The Atlas structure linked to the metadata (Aditya, et al.,2004)

For improvement of the structure of an electronic National Atlas various options could be added (e.g. interactive and dynamic functions, a realization of new analytical potential etc.). It should be done considering users' needs and demands.

2.2.3. National Atlas Bureau

The role of a National Atlas Bureau is important in the process of a National Atlas creation. They deal with collecting and compiling, sifting and sorting, retaining and removing, and assembling and arranging data (Buckley, 2003).

Since a National Atlas Bureau is responsible for the quality of the National Atlas, the National atlas cannot function without atlas editors (Kraak, et al., 2009). Staff of a National Atlas Bureau would be able to provide well-designed and up-to-date maps (Aditya, et al., 2007). The atlas editors should be aware of the new geospatial information available by national data providers (Kraak, et al., 2009).

A National Atlas Bureau with staff plays an important role in the production of well designed National Atlas maps. A National Atlas Bureau is responsible to select data that would be sufficient for produce National Atlas maps. Also there are some problems (Buckley, 2003):

- cartographers are confined by the data they have
- the amount of time they have to compile
- the standard methods of compilation

It is important to keep maps up-to-date, but after update process the atlas would then lose some its esthetical attractiveness (Ormeling Sr, 1979). It is important to maintain well designed atlas maps through the update process. The contribution of cartographers with knowledge of design in computer mapping would be undoubtedly improving the situation (Ormeling Sr, 1979).

In this research the tasks and responsibilities of the National Atlas Bureau in the second edition of the Netherlands National Atlas (1989-1995) will be described and the tasks of National Atlas Bureau in the (semi) automatic update process of National Atlas maps in a GDI environment will be established.

Since there is a lack of information (in English) about the role and tasks of the National Atlas Bureau in the production of the second edition of the Netherlands National Atlas, we interviewed people have been involved in the second edition of the Netherlands National Atlas.

The second edition of the Netherlands National Atlas (1989-1995) was focused more on the inhabitants compare with the first edition of the Netherlands National Atlas (1963-1978), which was focused mostly on the physical environment. The second edition of the Netherlands National Atlas consists of twenty books with different themes (population; history of habitation; cities; towns; living; recreation; work; businesses; agriculture; port of Europe; infrastructure; soil; water; landscape; environment; environmental planning; spatial planning for cities; spatial planning for towns). Each book has a group of theme editors (experts from different organizations, ministries, universities, municipalities etc.), an editorial committee (with 10-11 persons), and an atlas bureau (with 4-5 persons). One design has been made for the whole atlas edition with collaboration of theme editors, editorial committee and atlas bureau. The design template has been designed in such a way, that one map (scale 1:1mln) should fit to one page. There are tree columns in each page, for maps, and also for additional information, like text, diagrams relevant to the topic. One book contains approximate 65 maps, in each book should be minimum one maps with 1:1mln scale, also there are maps with 1:2mln, 1:3mln. Various map types can be found in each book (e.g. chorochromatic, choropleth, cartogram, dot maps, isoline maps, proportional symbol maps, combination of different map types, diagrams, pyramids, etc.). The base map for these

different kinds of maps has of course the same design, made by cartographers from the atlas bureau in collaboration with the editorial committee and theme editors. The editorial committee, theme editors and atlas bureau with staff played an important role in the production of the National Atlas. They had different tasks and responsibilities in this process.

Theme editors: The theme editors were experts from different fields, relevant to the theme of the National Atlas. The Ideas (about the content of the atlas), data, material have been delivered by them. They were involved in model correction that has been created by the atlas bureau.

Editorial committee: The members of editorial committee developed the idea of 20 books of the Dutch National Atlas considering its purpose and audience. They have been involved in map design process (in the beginning of design process, and also at the final stage) in close collaboration with atlas bureau. Also they participated in model correction.

Atlas bureau with staff: They did proposals about map design (which classification methods could be used, how many classes, the number and choice of printing colors). They have been involved in drawing, in making maps, in creating models. After discussions with the editorial committee and theme editors, models have been corrected by the atlas bureau.

The production flow of the second edition of the Netherlands National Atlas includes the following steps, from idea to printed maps:

- idea
- first sketch
- data collection
- cartographic design
- model creation
- editing (considering the opinion of editorial committee)
- model adaptation
- map specifications (base map; symbols; the number and choice of printing colors; text specifications)
- map title and legend determination
- production-instructions set up
- the actual production: drawing; color mask;
- color proof
- color proof judge through: editorial committee, theme editors and atlas bureau
- editing
- second color proof and checking
- printing

After this stage integration has been done.

- integration (maps, text, photos, diagrams)
- model creation
- editing
- second model

- printing

Many persons and authorities cooperated on the realization of the atlas. It has been done in collaboration between editorial committee, theme editors, and atlas bureau with staff. Based on calculations and estimations the following human effort has been put into producing the second edition of the Dutch National Atlas:

- 11 members of the foundation: on average 2 meetings per year;
- 11 members of editorial committee: on average 31 meetings per year;
- 40 experts from different fields have been involved in production of the atlas.
- total 70 authors: based on a rough estimation, 6 months have been spent per atlas part;
- 4-5 members of atlas bureau worked for 5 years for production of one book of the atlas, totally 25 years for production of the atlas.

2.3. Concept and methods of map design

William Morris Davis states: "It is just as important to study the proper and effective use of various forms of graphic presentation, as it is to study the values of different methods, treatments, grades, and forms of verbal presentation." (Robinson, 1966)

Design is the most fundamental, challenging, and creative aspect of the cartographic process (DeLucia, 1974). In order to answer a question how the cartographic design appears is important to understand: What design is; the purpose of graphic design; the process of graphic design; to work within limitations imposed on design by technology, the media, and operational logistics (Wood, et al., 1996). There are several design elements: thinking, problem-solving, systematic process, solutions, and product or discipline independence (DeLucia, 1974). All the design elements, like all the components of a map, are interdependent (Robinson, 1966). Based on these characteristics DeLucia (1974) defines design as: "a systematic thought process which yields solutions to a wide range of human problems. The process is logically independent of the specific nature of the systems or products required to solve those problems". If the design of a map fits concepts that have been selected before, cartography can be considered as functional.

There is a different approach of map design methodology that consists of stages. DeLucia (1974) divides the design process into five stages:

- problem identification and definition
- search for solutions
- evaluation of alternative solutions
- selection of the optimum solution
- production

Dent (1993) defines the following stages of the map design process:

- ideas and concepts are generated

- the development of the graphic structure in which the geographic and thematic information is assigned to various visual levels
- the preparation of the worksheet and the specifications for the cartographic marks that would convey the intended cartographic message.

According to Brewer (2005) the basics of designing better maps are the following:

- designing for map purpose and medium, considering audience, media resolution, viewing distance, and color quality
- linking layout to map purpose, using visual hierarchy, editing decorative design elements, and selecting map projections
- planning a layout, balancing empty spaces, refining alignments in layout, and valuing experimentation and critique
- choosing appropriate export options, including raster formats, vector formats, and maps for the Web

Based on the above mentioned methodologies of the design process, I would suggest examining widely the map design process defined by Dent (1993) that consists of six essential stages of the map design process(these stages will be described in chapter 3):

- problem identification
- preliminary ideas
- design refinement
- analyze
- decision

For effective design a clear understanding is required of how maps are read, as well as how graphic information is processed (Moore, 1981).

Automation is a technique in cartography that has many advantages compared to traditional approaches to map preparation and production. Automated map design aims to perform the cartographic operations and to write the algorithms, and not focused on cartographic design. Using automation in mapping is not as time consuming and not as expensive as using the old media. But there is a question about the role of map editors in this age of automation (Wood, et al., 1996). There are two stages in design process. At the first stage (problem definition and structuring) a computer algorithm can be used. At the second (the design process) human interaction is necessary. It is unlikely that a computer will ever replace the creativity and imagination that a skilled cartographer brings to map design (Wood, et al., 1996).

2.3.1. National Atlas maps design and production

National Atlases are one of the most expensive and sophisticated of all cartographic products (Keates, 1989). It is obvious that National Atlases provide mostly thematic maps. As mentioned in the chapter1 there are National Atlases as book form, electronic atlases, and online atlases. Regardless of the medium, however, the thematic cartographer continues to need sound design principles (Dent, 1993). Many of the best examples of

cartographic representation can be found in National Atlases (Keates, 1989). There are various base maps that are needed for National Atlas maps to present special subjects. It is important to choose correct reference information and of course correct design approach.

2.4. Geospatial Data Infrastructure (GDI)

2.4.1. Concept of GDI

The principle “collect once, use many times” is very much relevant to the Geospatial Data Infrastructure. Geospatial Data Infrastructures (GDIs) have been defined by Groot and McLaughlin (2000) as “a set of institutional technical and economical arrangement , to enhance the availability (access and use) for correct, up-to-date, fit-for-purpose and integrated geo-information, timely and at an affordable price, with the goals to support decision making processes related to countries’ sustainable development”. GDIs are highly organized, standardized and institutionalized, large collections of spatial data and services (Köbben, et al., 2009). It is obvious that there is a need to access and share geospatial information considering some standards, that can be done using GDI, which allows sharing data from different sources and helps users to save resources, time and efforts to enquire new datasets (Rajabifard, et al., 2001). The notion of a Geospatial Data Infrastructure as a tool for providing effective access to geospatial data was realized first in 1980 in Canada (Groot, et al., 2000). Later more than 100 countries have developed GDIs (Aditya, 2007).

An interoperability of the components plays an important role in GDI environment. There are two types of interoperability: technical and semantic, both are a challenge, but semantic interoperability is more complicated (Köbben, et al., 2009). In general data providers don’t think much of data integration with other data sets and the users considering their needs mostly require data from different sources that is always big challenge. Using GDI is important to consider this problem that allows integration of different data sets. GDI is intended to facilitate both users and providers’ needs (Aditya, et al.,2007). It is important to mention that GDI has ability for offering decision supports and enabling geocollaboration (MacEachren, et al., 2005). The main goal of GDI is the sharing, access to, and responsible use of geospatial data for a specific application domain and enterprise (Groot, et al., 2000).

A Geospatial Data Service Centre plays an intermediate role between data users and data providers in context of a specific application domain and enterprise (see Figure 2.2). It allows to access data considering the administrative, data security, financial services and also data standardization activities (Groot, et al., 2000).

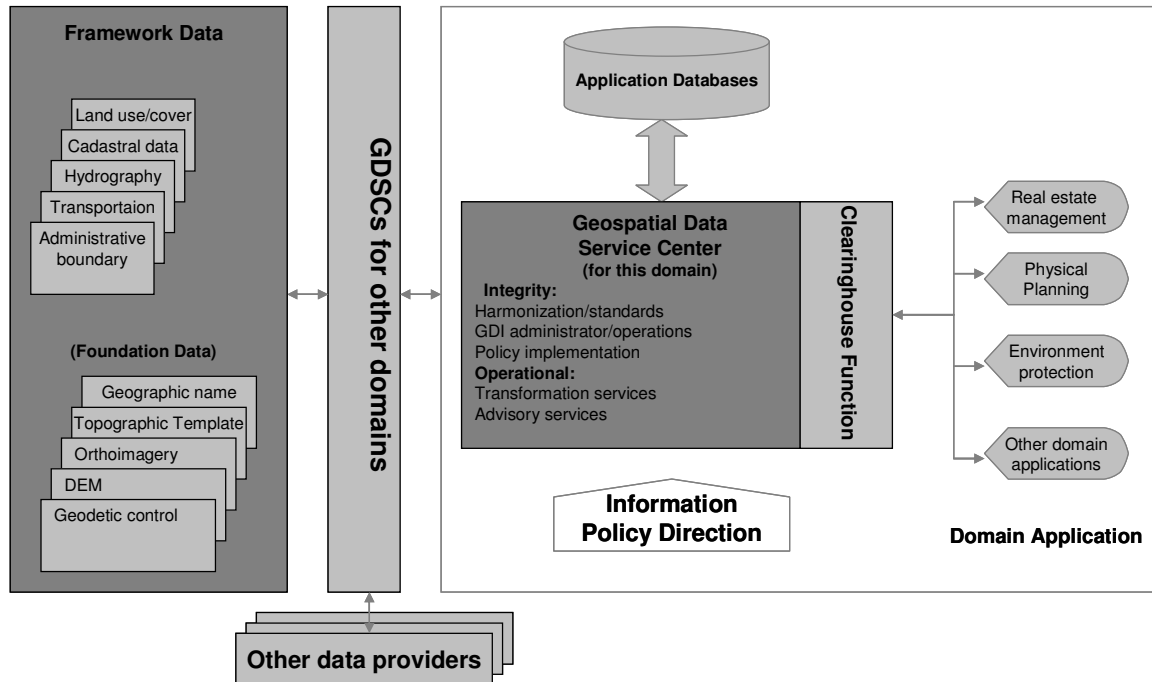


Figure 2.2 Role of a Geospatial Data Service Centre (GDSC) (Groot, et al., 2000).

A National Geospatial Data Infrastructure (NGDI) seeks to support the sharing and management of spatial data in the national context considering a set of standards (i.e. national spatial reference systems, a national topographic template, a national elevation model etc.) and also metadata standards. Since data standardization has been applied there is no need to link enterprise and domain –oriented GDIs into an NGDI (Groot, et al., 2000).

2.4.2. Geo-Webservices

Web services convert an application into Web-application. They are published, found, and used through the web. Web services have several interesting characteristics (URL1):

- Web services are application components
- Web services communicate using open protocols
- Web services are self-contained and self-describing
- Web services can be discovered (e.g. using Universal Description, Discovery and Integration)
- Web services can be used by other applications
- XML is the basis for Web services

There are several Geo-Webservices in a GDI environment. Some of them are developed and owned by commercial companies (e.g. Google Maps, MSN Virtual Earth, Yahoo Maps and etc.) and the Open Web Services (OWS) of the Open GeoSpatial Consortium (OGC), they latter are Open Standards for Geo-Webservices (Kraak, et al., 2009). There are OGC specifications that are used for spatial data storage analysis and dissemination process (URL1):

- Catalog Services Interface Standard (CSW) allows publishing and searching metadata about geospatial data. It is used to register metadata by data providers, and also specifies an information model, that includes information about spatial references and thematic information.
- Geography Markup Language (GML) is an XML grammar for describing geographical features. It is a modeling language used in geographic systems and also for geographic transactions on the internet. There are two parts: the schema (describes the document) and the instance document (contains the actual data).
- Web Coverage Service (WCS) allows interoperable access to geospatial data that has values at each measurement point (e.g. satellite images, digital aerial photos, and digital elevation data).
- Web Feature Service (WFS) enables to retrieve geospatial data (vector data) using Geography Markup Language (GML).
- Web Processing Service (WPS) allows standardizing input and output for geospatial processing services. It characterizes an interface, which helps to publish geospatial processes. The data used by WPS can be available at the server.
- Web Map Service (WMS) allows displaying map images from distributed geospatial databases using HTTP interface. WMS request defines the geographic layers to be processed, and response is one or several map images (JPEG, PNG, etc) to be displayed using a browser application.

All service specifications are collectively referred to OGC Web Services (OWS) and they adhere to communication via HTTP as the distributed computing platform (Kralidis, 2005).

2.4.3. Geo-portals as part of GDI

According to Groot and McLaughlin (2000) Geospatial Data Infrastructure supports the sharing of spatial data. Geo-portals play an important role in the sharing process. Geo-portals are web applications where geographic content can be discovered (Maguire, et al., 2005). According to these authors geo-portals have the following characteristics:

- geo-portals organize content and services (e.g. directories, search tools, community information, support resources, data and application).
- geo-portals supports to query metadata records and then link directly to the on-line content services.
- geo-portals control commercial usage of services (the sale/purchase of data and services).

Koshkarev (2008) states that “The geo-portal is a set of tools for purposeful and deepened search of various thematic spatial data in the “geo-directory” following the request of a basic or extended search by addresses, postal codes, geographical names, coordinates, etc.”

There are two groups of geo-portals (see Figure 2.3) (Maguire, et al., 2005):

- catalog geo-portals enable organizing and managing access to Geographic Information (GI)
- application portals provide on-line, dynamic geographic web services.

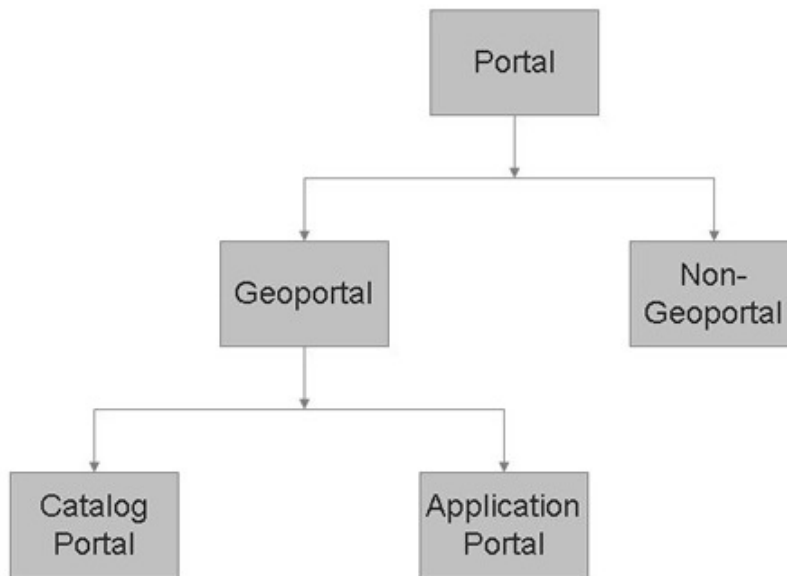


Figure 2.3 A classification of geoportals (Maguire, et al., 2005)

Also geo-portals can be classified into two groups considering the type of geospatial resources (Aditya, 2007).

- national or regional geo-portals (e.g. the US Geospatial One Stop-GOS; GeoConnections; Inspire geo-portal)
- thematic geo-portals (e.g. the Food and Agriculture Organization (FAO) portal; European Protected Areas portal; Earth Science Gateway)

Geo-portals provide catalog services (Maguire, et al., 2005). They enable publication and discovery of collections of geospatial resources (offline and online data services). For data publication metadata is created by data providers using the catalog client. For data discovery catalog services should include tools for querying and presenting metadata records (Aditya, 2007). Figure 2.4 shows the role of a geo-portal in a GDI.

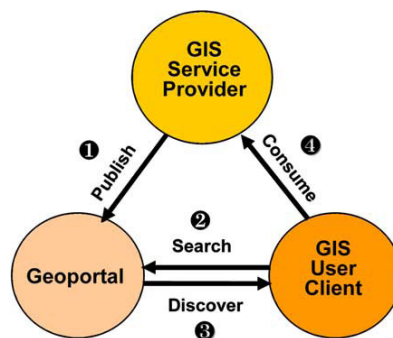


Figure 2.4 The role of a geo-portal in a GDI (Maguire, et al., 2005)

Current geo-portals have some disadvantages: lack of search capabilities and lack of appropriate navigation tools (Aditya, et al.,2006).It is important to improve usability of geo-portals considering users' needs. There are users with different backgrounds and skills; it is obvious that their needs are various in terms of using geo-portals to discover data. Providing effective search capabilities and effective visualization (i.e. space-time plots, parallel coordinates plots and etc.) is very important and effective discover and explore spatial data, but it is still challenge to explore data from different sources and their relationships, because of the lack of search capabilities (Aditya, et al.,2006). The National Atlas as portals could be used to improve data searching, discovery, accessibility in a GDI environment.

2.5. National Atlas in GDI environment

2.5.1. National Atlas as portals

The concept and role of National Atlas have been renewed over years. Aditya and Kraak (2005) proposed to use the atlas as a portal to discover geospatial data, in the other words using atlas metaphor to locate, choose, and make use of geospatial data (Aditya, et al., 2004). Aditya and Kraak (2006) define atlas metaphor as: "the atlas is used to organize and represent not only assorted thematic spatial information but also information regarding metadata within the GDI through functionalities commonly offered in paper and, especially, electronic atlases (e.g., navigation and browsing based on area or topic, legend, GIS analysis)". In this metaphor there is a target (object) and a source (the concept used to provide insights about the target) (Hamilton, 2000). The National Atlas can be considered as the source and the GDI as the target (Aditya, et al., 2004). Using the National Atlas as a portal is effective and efficient, since it is easy to use because of familiar concepts and easy to access because of the topical atlas structure (Kraak, et al.,2009). The atlas as a geo-portal can be used effectively to access data and services in GDI framework since the atlas has three positive characteristics (Aditya, et al., 2005):

- providing structural navigation
- broader access to the relevant data and links
- comparisons capabilities

The atlas contains multi-thematic information. This information in the atlas are posed with the metadata and information related to the GDI. There are some problems in terms of data accessibility using the atlas (Aditya, et al., 2005):

- the GDI involves interactions across policy, social, economy, and technology aspects
- to have up-to-date information in GDI requires a cooperation and collaboration across the institutions
- a schema for mapping metadata for data discovery tasks is needed

The atlas as a portal can not be considered only as a tool for geospatial visualization, it can function a decision making tool (Kraak, et al.,2009).

2.5.2. National Atlas information structure

The organization of an atlas's content is the atlas information structure (Aditya, et al., 2006). It can be considered as the directory of the atlas to help users to access and retrieved

information required (Aditya, 2007). There are several topics in an atlas that are linked to relevant maps. This allows consistent visualization of specific themes. The atlas information structure manages the range of the topics and relationships between related images and graphics. It is important to include metadata into the atlas information structure. The multivariate visualization of the metadata supports discovery tasks performed (Aditya, et al., 2005).

2.5.3. Metadata visualization

The characteristics (e.g., geographical coverage, quality, source, and lineage) of the data in a GDI environment can be accessed through metadata. Metadata provides information about data for users and providers. In order to manage data a catalogue is created by data provider using metadata. For determination of fitness for use of data are used metadata on the user's side (Aditya, et al., 2006). Metadata summary consists of five important elements: geographical, topical, temporal coverage, accessibility and usage elements. They can be considered as abstract classes and are used to explore the data characteristics for assessing their fitness for use (Aditya, et al., 2005). In order to help users visually locate the data required, these five elements are mapped as symbols (Aditya, et al., 2006). Different graphic variables could be applied to visualize these symbols based of course on the nature of the elements (quantitative or qualitative). The differences of metadata to allow comparisons can be seen as qualitative differentiation, ordered differentiation, and proportional differentiation (Kraak, et al., 2003). To portray these differences some visual variables are used for representation of the value of each element (Aditya, et al., 2005).

2.6. Summary

In this chapter has been discussed the concept of atlases in general and particularly concept of National Atlases. We can say clearly that atlas is a combination of maps and it has several characteristics, which is typical for a National Atlas as well (e.g. all information is displayed at the same scale, the same level of generalization is applied, and similar classification methods are used etc.). Maps comparison is an important aspect of a National Atlas and of course its narrative functions (it tells a story). The role of a National Atlas Bureau with staff is very important in order to maintain well designed maps in general and after the updating process. In design process a human interaction is necessary to have well designed maps. Another important concept relevant to this research is a Geospatial Data Infrastructure (GDI). It is a large collection of spatial data and services that allows sharing geospatial data from different sources considering standards. An atlas can be used as a portal for discovering geospatial data. In this context, it can be considered also as a decision making tool. The atlas information structure is function as an organization of an atlas's content, it is important to include metadata into the atlas information structure, which is used to access information about data in a GDI environment.

3. (Semi) automatic update process

3.1. Introduction

In the previous chapter we presented a concept of National Atlas, a concept of GDI, the role of the National Atlas Bureau with staff in map design process and in the update process of National Atlas maps. In this chapter a map design process and its essential stages will be presented defined by Dent (1933). We will talk about the knowledge-based cartographic expert systems that are capable of automated map design, also how a mapping process and map updating process can be done automatically and which part requires a human interaction. For this reason we designed update process flows for different map types that are represented by 5 scenario's for the updating process.

3.2. Map design process

Design is more than simply drawing something, it is “the invention and disposition of the forms, parts, or details of something according to a plan” (Moore, 1981). The cartographic design tries to transform the knowledge between map author and map user efficiently. Map design could be considered as a functional relationship between map author and user. The map design process is a complex activity that includes both intellectual and visual aspects (Dent, 1993). The design process starts with the symbolization of the map information. It is important to define the map's purpose, why the map author wants a map and what he expects to achieve. The map design process ends with implementation. Dent (1993) defines six essential stages of the map design process (see Figure 3.1).

Problem identification: this stage includes the establishment of needs and design criteria; the identification of map purpose and map audience; also some limitations are identified in this stage.

Preliminary ideas: this stage can be considered as most creative stage in the design process, since preliminary ideas are formulated in this stage.

Design refinement: in this stage all preliminary ideas that have been set in the previous stage are evaluated, which could be accepted or rejected. This stage is important since the decisions that are made here affect the whole design process.

Analyze: Models are created in this stage. It is used to develop detailed drawing by cartographers.

Decision: some changes are made in this stage. The decisions that have been made in the previous steps may be accepted or rejected.

Implementation: this is the final stage of the design process, final map production is begun.

Feedback: It is a continuous process. It assists a map designer to improve the product in context of map design.

Projection: is an important process, it helps a map designer to see the end product and possible problems, also helps decision making along the way. To be able to understand the final solution is very important in terms of reducing wrong choices in map design.

In order to get well designed maps, the stages of the map design process can be repeated several times.

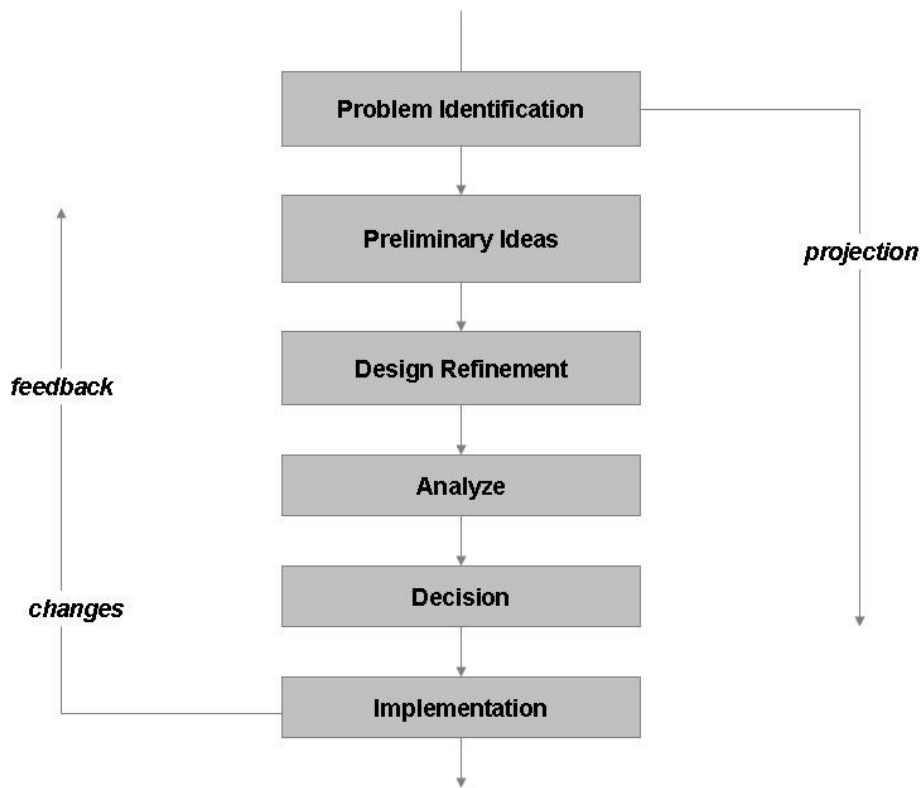


Figure 3.1 The design process (Dent, 1993)

As mentioned in chapter 1 a National Atlas is a collection of maps. It is important to have well designed atlas maps. In this research we have already described several approaches of the map design process that could be acceptable for the design of National Atlas maps. Usually a design template is designed for each topic and a National Atlas Bureau is responsible for it. The elements of a design template are defined and fixed by this National Atlas Bureau.

3.3. An automated map design

Within this design template special attention goes out to the auto-creating and auto-updating of the maps (Kraak, et al., 2000). The knowledge-based cartographic expert systems are capable of an automated map design. An expert system is a program which includes a codified form of the rules that an expert uses to solve a problem, thus a cartographic design expert system would include the rules a cartographer uses when designing a map (Forrest, 1993). There are some considerations that need to be overcome with respect to the design of automated mapping systems (Wood, et al., 1996):

- there is a need for a formalized, overall conceptual framework for automated cartography.
- there is a need for a more user-centred perspective in the design of such an automated cartographic system.
- there is a widening gap between analog cartographic products and interactive visualization.

According to Forrest (1999) a cartographic design expert system includes three main elements (see Figure 3.2):

- an inference engine that is responsible for the control of processing and the search of solutions.
- a knowledge base stores facts (the particular range of maps the system “knows” about) and design rules.
- a user interface uses the design rules in searching for solutions.

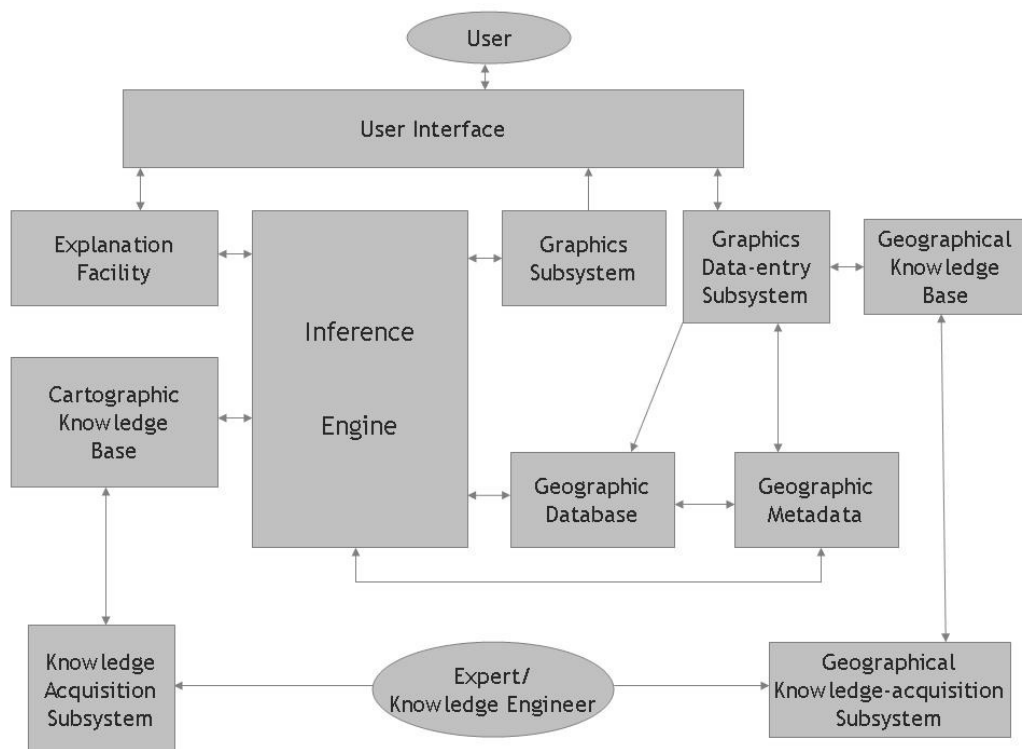


Figure 3.2 The architecture of a Cartographic Design Expert System (Forrest, 1999)

The information about the nature and structure of geospatial data to be used by an expert system should be stored as metadata. In order to be automated many stages in the mapping process require further knowledge about the data available for mapping (Forrest, 1999).

It is a problem to create and maintain well designed maps using computer systems. Forrest (1993) states that most programs have the capability of producing well designed maps when used by someone knowledgeable in map design. It means that poorly designed maps are not the fault of the computer programs. In order to create well designed maps, it is important to define the rules of cartographic design. The map design is the first step of a cartographic design expert system creation process. In the map design process the type of maps and an appropriate scale range must be defined. According to Forest (1999) an expert system follows a similar route to a cartographic expert. He defines the stages of the design process of the cartographic expert and of the cartographic expert system:

| | |
|--|---|
| <i>The cartographic expert:</i> | <i>The cartographic expert system:</i> |
| Requirement assessment | Description |
| Composition | Layout |
| Compilation | Data Selection |
| Symbol specification | Symbolization |
| Production | Display |
| Adjustment | Modification |

Several researches have been carried out in automated mapping. An automated visualization design based on data characteristics was proposed by Bertin (1983) and McEachren (1995). An example of a knowledge-based system is the Descartes system, developed by Andrienko (1999). It is the first system on automated data mapping considering semantic relationships among data components. For intelligent map design , it is important to present in the system a certain degree of understanding of data semantics (Andrienko, et al., 1999).

Forrest (1999) defines four aspects to be considered in describing spatial data:

- the nature of the phenomenon being mapped
- the location data about the phenomenon that are available
- the definition or nature of measurement of the characteristics(attributes) of the phenomenon
- their possible cartographic representation

Forest (1999) states, that to explore the relationships between the four elements plays important role in automatic selection of the most appropriate representation method(s) for mapping process.

Mapping methods are standardized ways of applying the graphic variables for rendering information components (Kraak, et al., 2003). These methods are based on measurement scale, graphical variables and data distribution (it is continuous or discontinuous). There are various map types. According to Freitag (1992) there is a subdivision of different types of map that based on their attributes: measurement scale and graphical variables (see Figure 3.3).



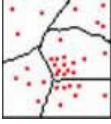
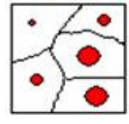



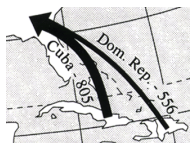
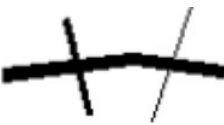
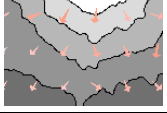








| | | qualitative | quantitative | | |
|----------------|-------------------|--|---|--|---|
| | | nominal | ordinal/interval/ratio | | composite |
| disc rete | Graphic variables | variation of hue, orientation, form | repetition | variation of grain, size, grey value | variation of size, segmentation |
| | point data | nominal point symbol maps   | dot maps  | proportional symbol maps  | point diagram maps  |
| | linear data | nominal line symbol maps   | | flowline maps  | line diagram maps  |
| | a) lines | | | | |
| | b) vectors | | standard vector maps  | Graduated vector maps  | |
| contin uous | areal data | Chorochromatic maps  | regular grid symbol maps  | Choropleth  | areal diagram  |
| | surface data | | isoline map  | filled-in isoline map  | |
| | volume data | | | smooth statistical surface  | |

Figure 3.3 Subdivision of map types (according to Freitag, 1992; Kraak, et al., 2003)

3.4. An automated update process for the National Atlas

To keep a national atlas maps up-to-date in Geospatial Data Infrastructure (GDI) environment is not a big challenge using a well organised data flow and map templates. But some problems can be expected to occur, when more data sources are available and significant changes take place for example in basic administrative boundary (a geometry of the base file is changed), or changes in attribute may require a different classification, that results a changing legend and possibly a changing map design.

Based on the literature review, we realized that there is a lack of information about an automatic update process of National Atlas maps. An important issue to be considered is that which part of this process can be done fully automatically and which part requires a human interaction. A human interaction is necessary to maintain well designed maps. In order to maintain well designed maps it is necessary to design a semi-automatic update flow in which a National Atlas Bureau with staff should be involved. Based on these considerations we designed an update process flow for different map types. As an example we selected choropleth and proportional symbol maps for scenarios that are used to describe an update process of national atlas maps considering different types of data changes. We met and interviewed people that have been involved in the Dutch National Atlas bureau, also people from the Bos Atlas at Noordhoff Publishers. We discussed the scenario's with them and got feedback on them. Based on this the scenario's have been corrected and improved.

Scenario 1 : Choropleth map; Statistical data is changed: Upper number of class boundary is changed. If there is no significant change then only first and second class boundaries are changed. In this case only text is changed in map legend. Decision is made about automatic update process based on change in map legend text. No human interaction is needed (see Figure 3.4).

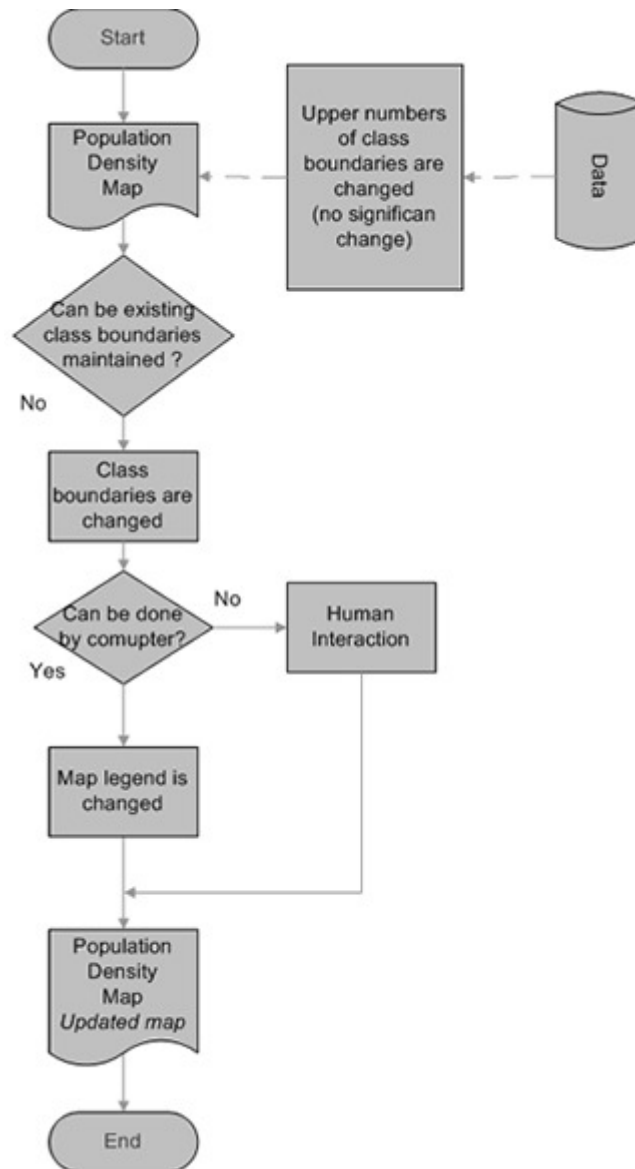


Figure 3.4 Process model diagram (Scenario 1)

Scenario 2: Choropleth map; Statistical data is changed: Upper number of class boundary is changed. If there is a significant change then all class boundaries are changed. Computer changes colors, gives appropriate colors based on different class boundaries, and also text is changed in map legend. Decision is made about automatic update process based on algorithm that can be used to change color and text in map legend. No human interaction is needed. An algorithm can be used to maintain map design without human interaction (see Figure 3.5).

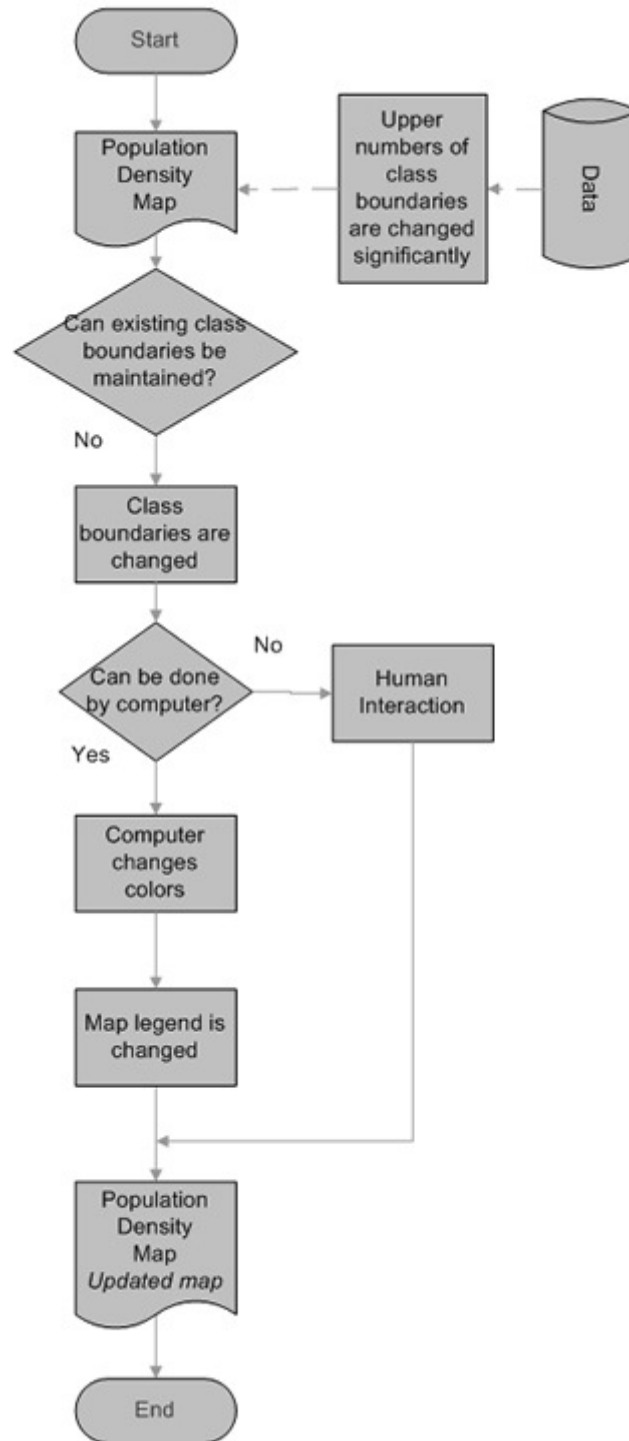


Figure 3.5 Process model diagram (Scenario 2)

Scenario 3: Choropleth map; Statistical data is changed: Data range is changed (it is increased). A decision is made to reclassify data based on new data range. To choose appropriate classification method (choose new method or use existing one) should be done by human. Based on the decision which is made by human, four stages are taken for updating map automatically: class boundaries are changed; text is changed in legend; computer changes colors; map design is changed. In this case a (semi) automatic update process is used (see Figure 3.6).

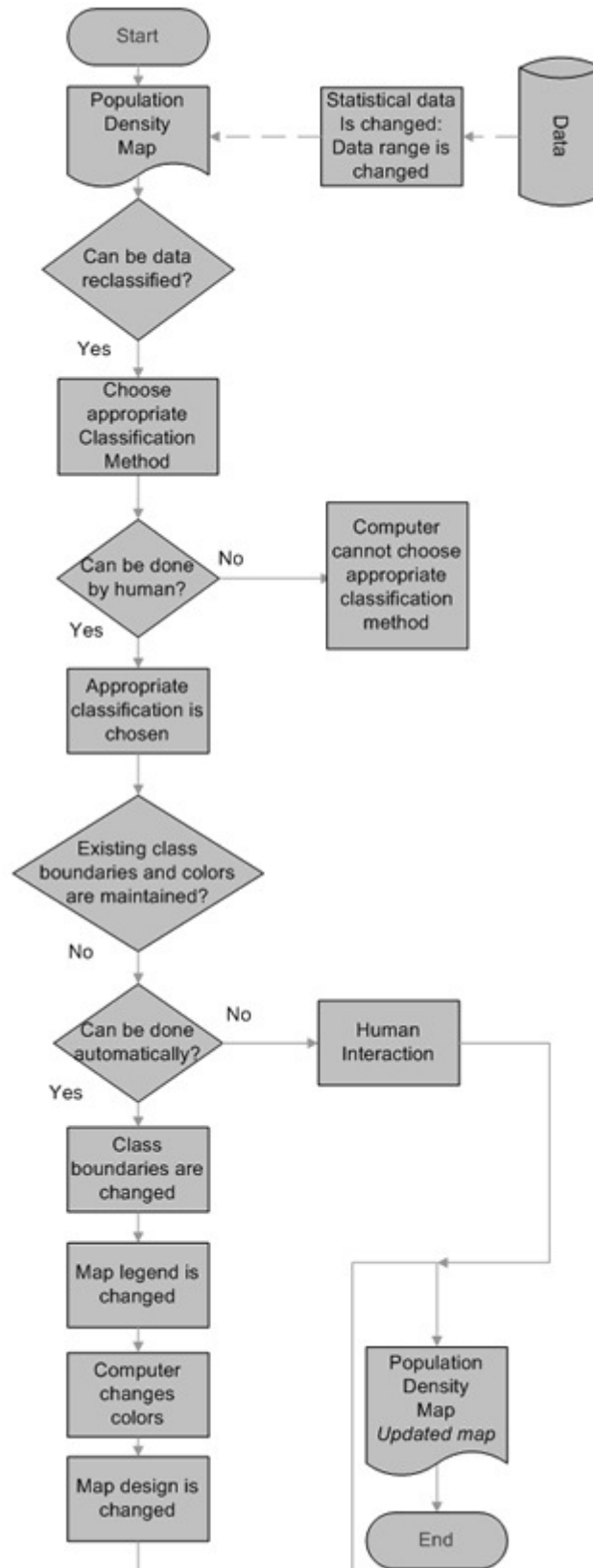


Figure 3.6 Process model diagram (Scenario 3)

Scenario 4: Choropleth map; Data change: Administrative units are changed (a municipality is split). Number of municipalities are increased, a new municipality is appeared, geography

is changed, attribute information is changes. Based on this decision is made, that updating process should be done by human interaction. Based on these changes class boundaries, map legend, map design is changed, that can be done automatically. For this scenario a semi automatic update process is required. Some part of update process can be done by human interaction, some part- automatically (see Figure 3.7).

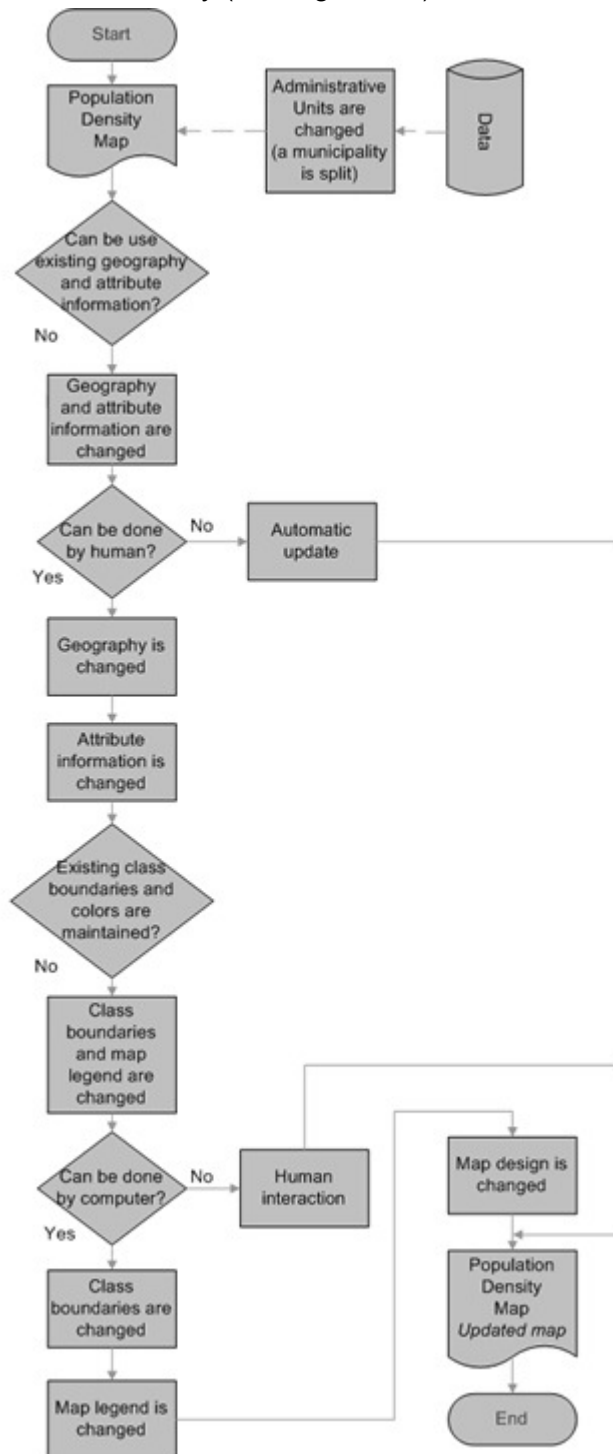


Figure 3.7 Process model diagram (Scenario 4)

Scenario 5 : Proportional point symbol map; Statistical data is changed: Absolute number of population is increased. Based on data change a decision is made that update process can

be done automatically. Graduated point symbols are used for visualization of absolute number of population. After updating process the size of graduated point symbols is increased, class boundaries are changed; text in map legend is changed. In this scenario (based on data changes) updating process can be carried out using fully automatic update process (see Figure 3. 8).

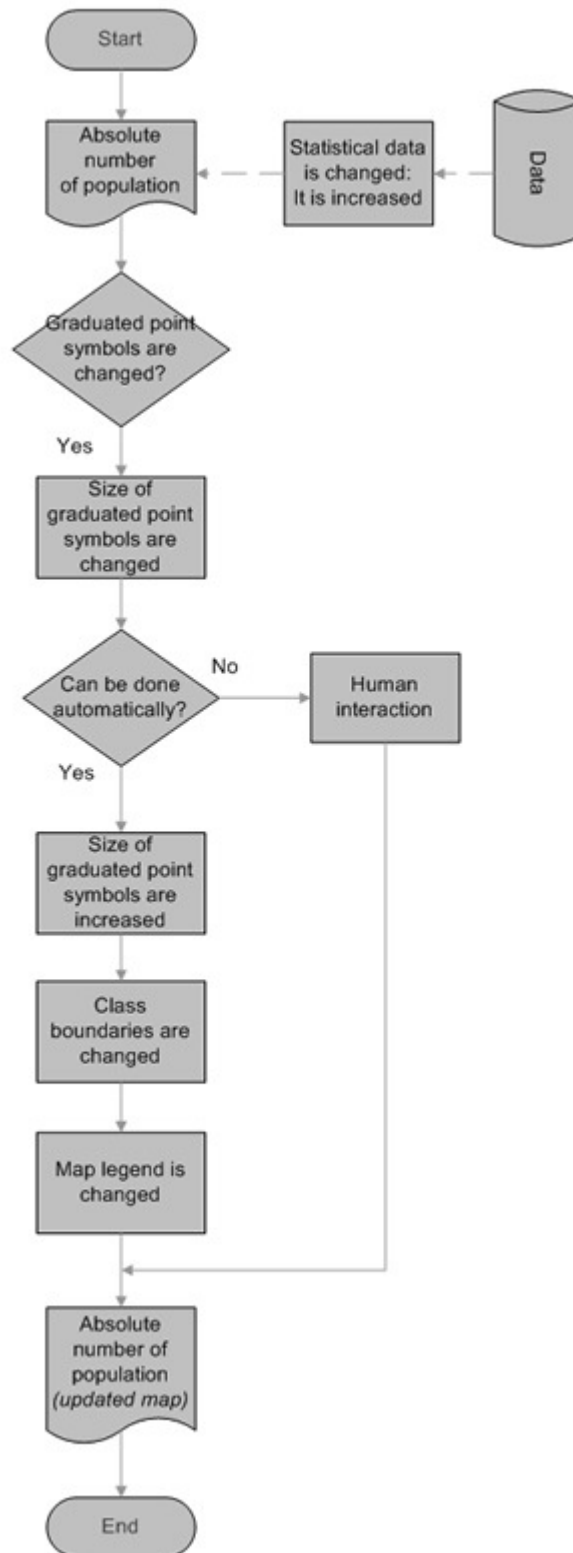


Figure 3.8 Process model diagram (Scenario 5)

We presented 5 scenario's that have been designed for updating process for different types of data changes. They will be implemented in practice. The first step is to make a conceptual design of the updating process and include the scenario's in this process, based on it we will be able to conclude, where in the update process a human interaction is necessary and where fully automatic update process can be done.

3.5. Summary

In the present chapter we have discussed about map design process and its essential stages, about automated map design using the knowledge-based cartographic expert systems that plays important role in automatic selection of the most appropriate representation method(s) for mapping process. It is important to keep National Atlas maps up-to-date in GDI environment and the same time to maintain well designed atlas maps. In this section an update process flow was designed and presented using 5 scenario's for different types of data changes that will be included in a conceptual design of the updating process that will give the clear picture, which part of the updating process can be done fully automatically and where is a need of human interaction. Based on it we will conclude about the role of atlas editors in the updating process.

4. Conceptual design of the updating process

4.1. Introduction

In the present chapter we are going to present a conceptual design of the updating process. But we are first going to describe a prototype of the Dutch National Atlas (3rd edition) that revives the concept of a National Atlas. It has its own design strategies, and of course an important part is the technical implementation of the prototype. Based on the current prototype we set up a conceptual design of the updating process that will be implemented. Also we designed a conceptual design of the update process that describes an overall picture of ideal situation, how the conceptual design of update process can be set up ideally. We described how the scenario's (they have been designed for update process flow by us) could be included in the update process of National Atlas maps. To maintain and display old maps an archival system of the National Atlas maps is introduced by us.

4.2. The Dutch National Atlas in a GDI environment

The Dutch Geospatial Data Infrastructure has been integrated with the Dutch National atlas to renew the concept of a National Atlas. To access the data through GDI is easy using a National atlas concept. Interactive atlas maps are created using the geodata and Geo-Webservices available through the GDI. Specific templates are used to make various datasets comparable. It is important to mention that National Atlas maps can function as alternative entry to the GDI (Kraak, et al., 2009). The data from different sources can be accessed using National Atlas maps.

4.2.1. The new National Atlas concept

A prototype of the Dutch National Atlas (3rd edition) has been implemented. It can be considered as a new concept of the National atlas since it is integrated with the Dutch Geospatial Data Infrastructure. The Dutch National Atlas has a modular design and provides a general overview of a country, which is very important in terms of usability. Using a select topic option, it is possible to display different types of interactive maps (based on a selected topic), that are depicted using the data from Geo-Webservices. The National Atlas maps are well-designed and comparable, since a design template is used in this prototype. It is important to distinguish between what was introduced by Aditya in his PhD study (2007) and what came out in current prototype. We will highlight which option is not implemented yet in the current prototype. There is the ability to search for a topic or for geographical names. In this case the Geo-Webservice will return all geographical names with the text string entered and map topic on the base map (Kraak, et al., 2009). There are internal and external spatial (and non-spatial) data at the server side. If a user needs to display spatial data, which is not located on the atlas server, it is possible to search and get alternative datasets with metadata. When we described a National Atlas concept, we mentioned, that the ability of map comparison is the main characteristic of National Atlas maps. It is possible to display

two maps with different topics and users can make comparison (e.g. comparison of spatial patterns). Another significant characteristic of a National Atlas is that it tells a story about a country. The Dutch National Atlas has a storyteller option, which provides a narrative for each topic (not implemented yet). There are an export and an import function. A user can export particular map(s) to a Google Earth environment and combine it with the other data in this environment. Also a user can import the data to the National Atlas and combine it with National Atlas maps (not implemented yet). Part of the technological implementation of the National Atlas concept has been done by T. Aditya (2007) in his PhD study, other parts have been implemented in the RGI project nr 111.

4.2.2. Design strategies

The Dutch National Atlas (3rd edition) has its own design strategy. There are three principles which are significant in the development of the National Atlas interface (Kraak, et al., 2009):

- to provide a uniform interface to the Dutch GDI and well-designed maps have a priority
- to provide an overview is important; to have a modular design and serve different groups of users
- to consider users' needs

There should be two interfaces: an editor's interface and a user interface. The editor's interface is not implemented yet. Figure 4.1 shows the user interface. It includes three windows and contains the following components (Kraak, et al., 2007) :

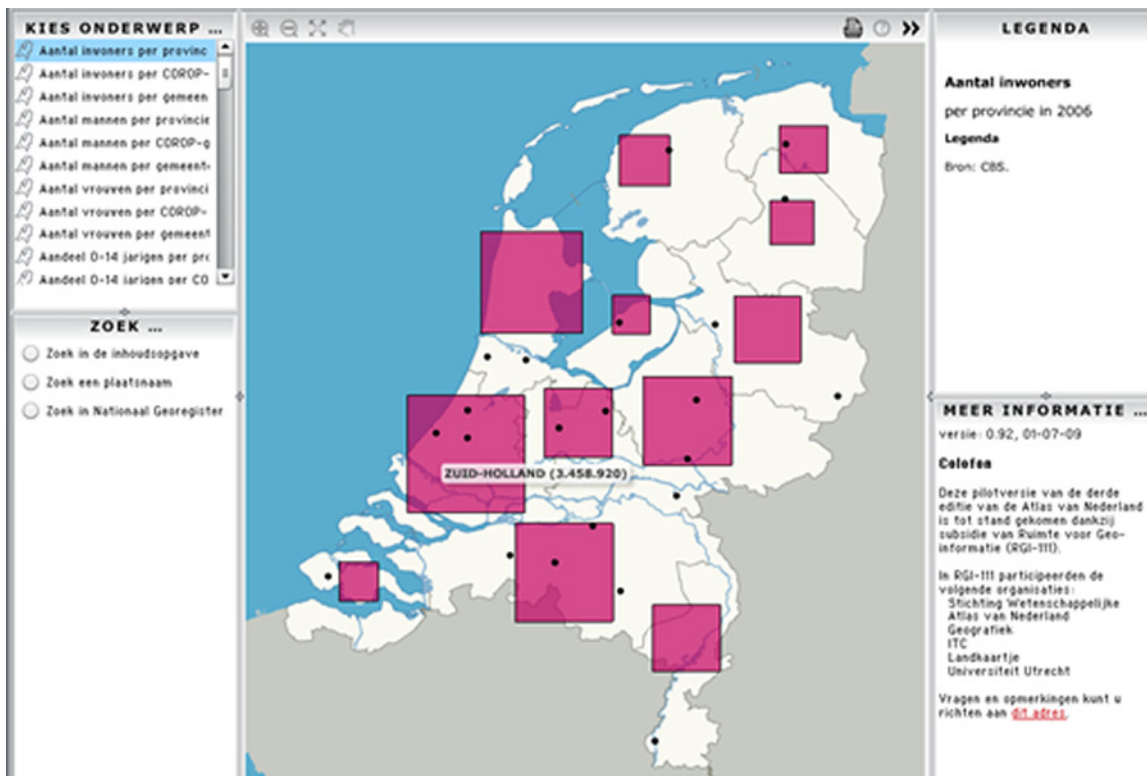


Figure 4.1 The user interface of the Dutch National Atlas

Selection of a topic and the search pane are located in the left side window. A user can select a topic and an interactive map will be displayed. It is possible to search by keyword or location using a search option. It is also possible to perform an advanced search using an advanced search pane. Using an expert pane, a user can select one than more topics and visualize multiple subjects (an expert pane is not implemented yet in the current prototype).

The toolbar and map area are located in the middle window. There is a toolbar at the top of the map area, which is not fully implemented yet. It contains several tools: zoom, pan, help buttons, also printing operation is available. 'More tool' contains additional tools, which perform measuring, exporting, importing the maps and etc., a user can manipulate the maps using additional tools. Raster and vector images are displayed on the map area. The vector format maps are interactive; the pop-up window shows additional information. Raster and vector images can be overlaid which is not implemented yet. The map design is predefined since a design framework is used.

Key and storyteller are located in the right side window. The key shows the title of the map; the legend; the scale; source and copyright. Using the storyteller a user can get additional information about selected map(s) (the storyteller is not implemented yet in the current prototype).

4.2.3. Technical implementation

For the technical implementation of the new Dutch National Atlas the Open Web Services (OWS) specifications of the Open Geospatial Consortium are used. According to the configuration of the technical implementation there are two function layers: one is at the server side and another one at the client side. They have different functions in this configuration. At the server side there are internal spatial data and non-spatial data that are offered by the atlas. The external data (spatial and non-spatial) is provided by national data providers, it is not stored at the atlas server. The visualization takes place at the client side (Kraak, et al., 2007). There are web services provided by data providers: Web Feature Service (WFS); Web Map Service (WMS). In general WMSes are often used for the delivery of maps. According to (Kraak, et al., 2009) the National atlas should use data services instead of portrayal services since WMS map is already made and for National Atlas maps we need to make a specific design template. Portrayal services will consume data from GDI WFS sources, and combine and portray that data in a cartographically sound client-side application (Kraak, et al., 2009).

The configuration of the technical implementation of the new Dutch National Atlas includes the following components (Kraak, et al., 2009): (see Figure 4.2)

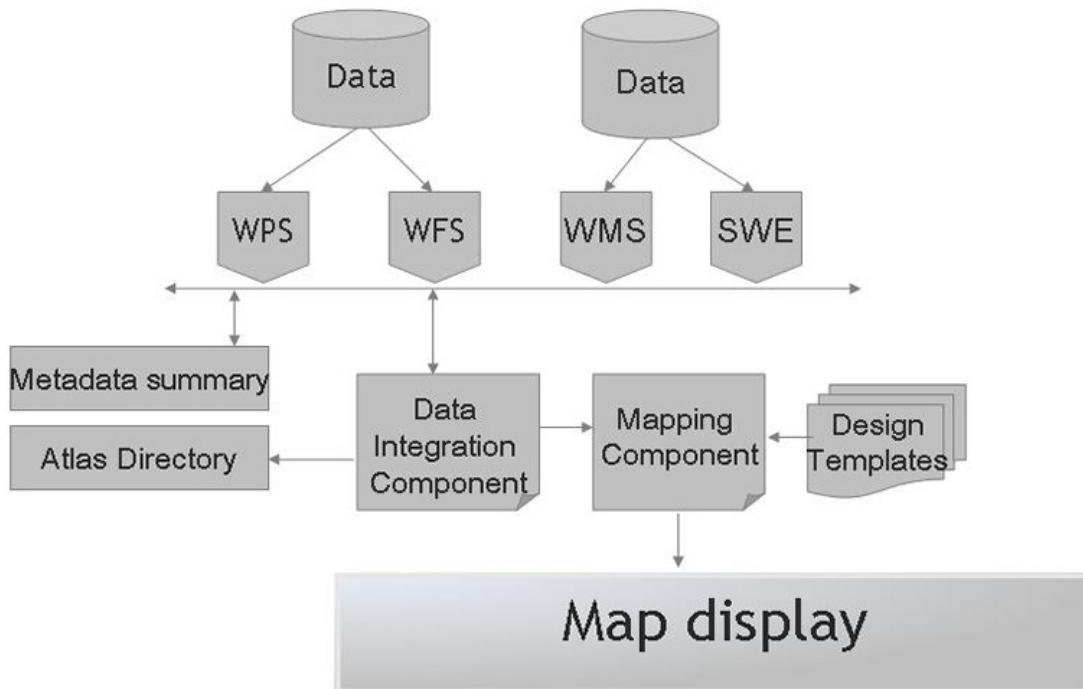


Figure 4.2 Technical implementation of the National Atlas prototype in the national GDI (based on (Kraak, et al., 2009))

- **Data integration component** integrates different datasets from various sources retrieved from services. The data integration component considers the scale and map types and based on it selects the best suited dataset.
- **Mapping component** defines which cartography and which design template can be used. It uses design templates to visualize the data.
- **Atlas directory** is used by data integration component and supports the atlas to combine external data with internal datasets.
- **Design template** is used to have pre-defined, constant map design, which guarantee well-designed atlas maps and make maps comparison possible. It is a part of the atlas metadata. It is stored in database and in XML files on atlas server side.
- **Metadata summary** describes external datasets, which are not stored at the atlas server, and are retrieved form national data providers.
- **Map display** visualizes the maps on the client side, using a vector graphics technology (e.g. Scalable Vector Graphics (SVG) or Flash), also it is possible to use the OpenLayers 'viewer'.

It is hoped that the Dutch National Atlas in GDI environment can be considered as a way of good management of geo-spatial information.

4.3. Set up of the updating process of a National Atlas in a GDI environment

For updating of a National Atlas maps in a GDI environment a conceptual design phase of the updating process has been set up. The conceptual design is based on the Open Geospatial Consortium (OGC) service-oriented architecture. OGC provides specifications of services with a standardised interface: Web Map Service (WMS); Web Feature Service (WFS); Catalog Services for the Web (CSW); Web Coverage Service (WCS); Web Processing Service (WPS); OGC was founded in 1994, it is a not-for-profit, international voluntary consensus standards organization. Its mission is to deliver interface specifications that are openly available for global use (URL1). OGC service-oriented architecture that has three main components: Requester; Provider; Register; (see Figure 4.3)

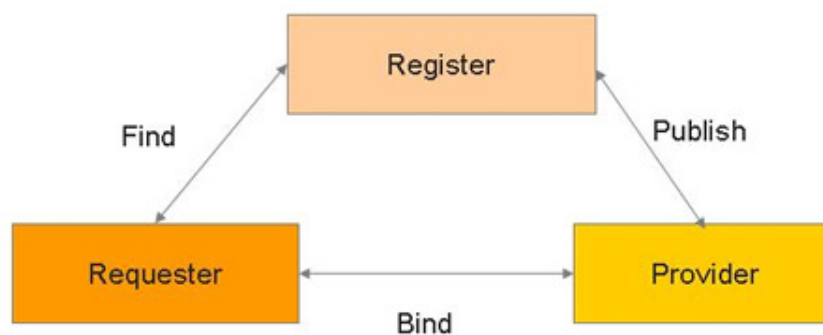


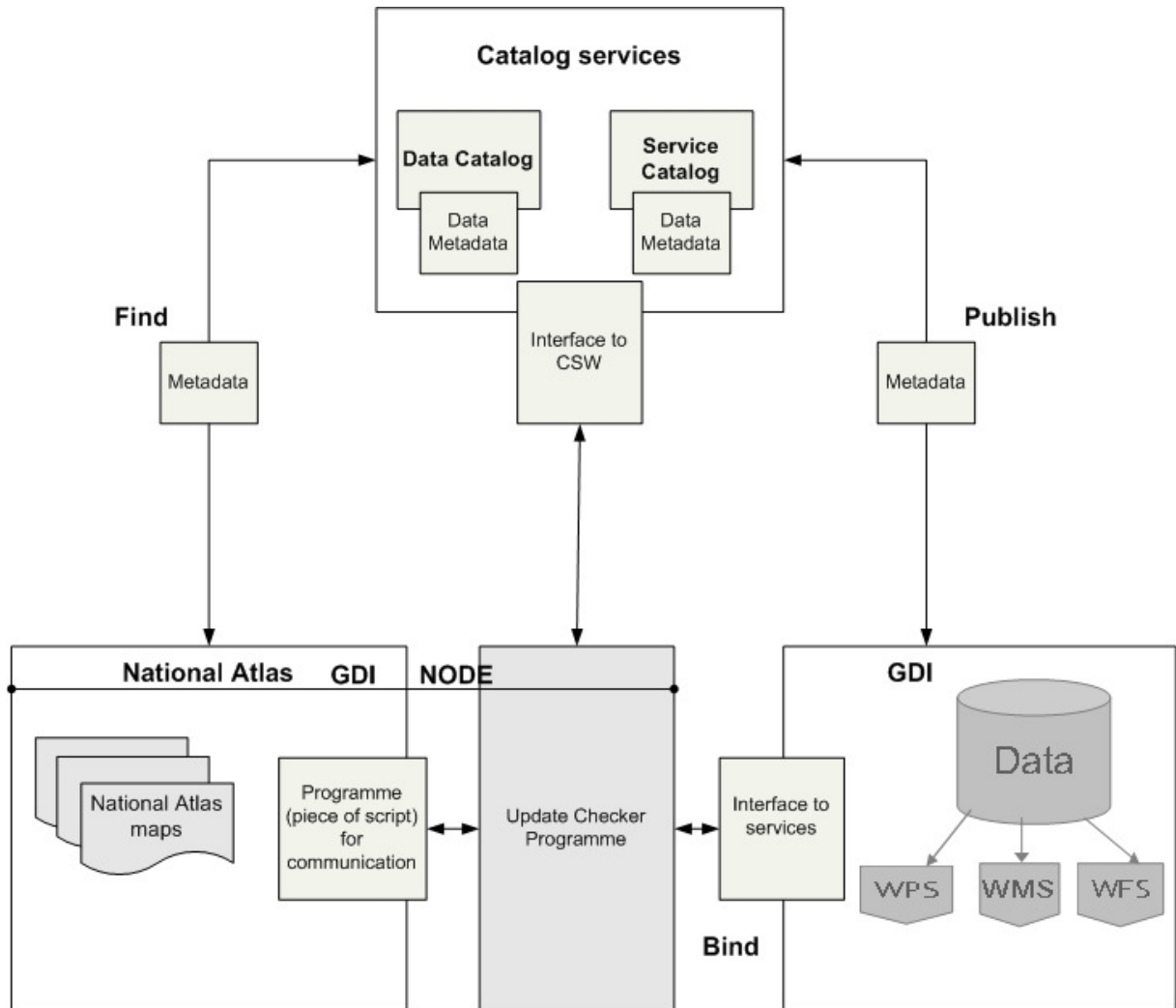
Figure 4.3 Service-Oriented Architecture (SOA)

To communicate between these components there is a need to standardise messages that are requests and responses. They are standards-based XML messages, which make systems interoperable, it means that they are able to access functions seamlessly and transfer data seamlessly. Interoperability is one of the most important challenges. According to ISO (1993) (URL2) interoperability can be defined as: "The capability to communicate, execute programs, or transfer data among various functional units in a manner that requires the user to have little or no knowledge of the unique characteristics of those units." As mentioned above using XML functions can be accessed seamlessly and to transfer data seamlessly Geo-Webservices are needed that make up a GDI. GDI is one of the components of the conceptual design of the updating process of National Atlas Maps. In this updating process, the National Atlas can be considered one of the application services that use a design template for the maps; also it should be treated as another node in GDI. The data providers publish metadata descriptions in catalog services. A catalog service supports the ability to publish and search collections of descriptive information (metadata) about geospatial data, services and related resources (URL1). Providers of resources use catalogues to register metadata that conform to the provider's choice of an information model; such models include descriptions of spatial references and thematic information (URL1). There are data catalogs and service catalogs in a catalog service. A data catalog contains data metadata that is maintained by data providers. Metadata is the background information describing the content, quality, condition and other appropriate characteristics of the data (Kraak, et al., 2000). Standards should exist to access and understand metadata easily. In the set up of the conceptual design of the updating process of the National atlas

maps, metadata descriptions should include information about the last update of data that will be used by an update checker programme, which checks the metadata for updates. As mentioned above National Atlas can be treated as a GDI node, National Atlas service in GDI, in this case National Atlas data metadata can be found in data catalog, that is stored in catalog service and National Atlas service metadata in service catalog, that is part of catalog service too. National Atlas data metadata describes data about atlas, which maps, which map subjects can be found in National Atlas. Also a National Atlas map design template can be considered as a piece of metadata, it can be maintained in a data catalog, but the elements of the design templates should fit to an existing metadata standards to be considered feasible.

The metadata stored in catalog services plays significant role to keep up-to-date National Atlas maps using the latest geospatial data that is provided by data providers. An important component of the updating process is an update checker programme. That is, for example, a piece of script that can be run at atlas server. It includes the actual updating programmes that have functions for fully automatic update process or for a (semi) automatic update process, depending on geospatial data changes in GDI. As mentioned above it checks the metadata for updates using catalog services. To check the metadata for updates, an update checker programme needs to access to the metadata database stored in data catalog. An OGC standardised interface, Catalog Service Web (CSW), provides access to the metadata database. If the update checker programme detects an update, it needs to access the updated data sets in GDI. In this case the OGC standardised interface to services (WFS, WMS and etc.) presents the updated data sets to update checker programme. There is a piece of script to communicate with the other components of the conceptual design. The latest updates from the data providers are uploaded onto the National Atlas and an up-to-date map is generated.

Figure 4.4 shows the set up of the conceptual design of the update process of National Atlas maps. The whole set up of updating process is described above and it is important to mention, that we described an overall picture of an ideal situation that is how the conceptual design of update process could be set up ideally. Nowadays this conceptual design of the update process can not done in reality since metadata, metadata standards not reach enough. At the moment there is not all metadata, which we need for such ideal system.



Interface to CSW----provides access to the metadata database;

Interface to services----provides access to GDI data and presents the updated data sets to update checker;

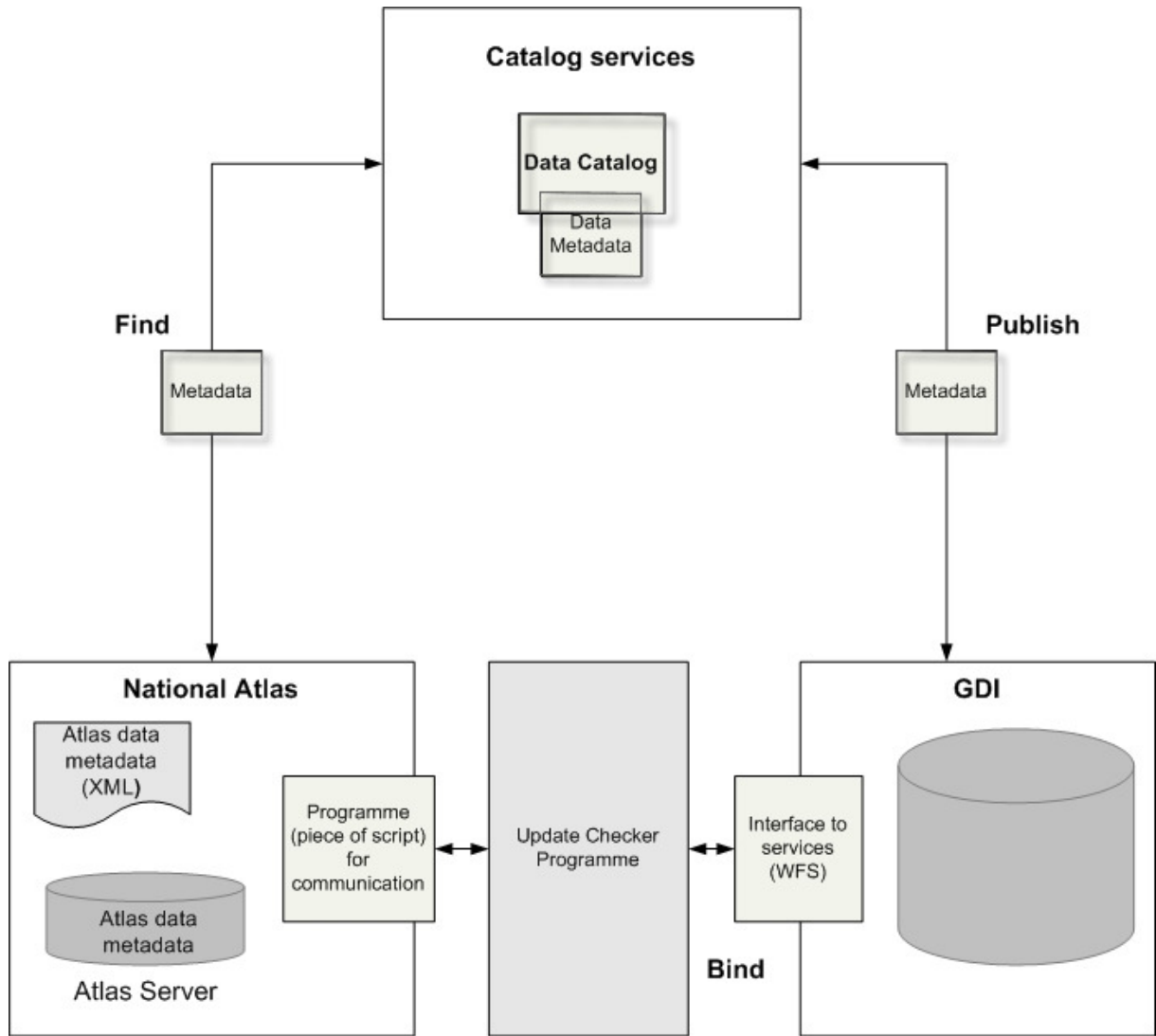
Update checker programme-----checks for the metadata for updates;

Figure 4.4 Conceptual design of updating process (overall picture of ideal situation)

A well organised data flow and design templates are important to keep National Atlas maps up-to-date in GDI environment. In the update process a significant role is played by the data providers' metadata descriptions to provide the latest data; a design template for the maps; an update checker programme for checking for the metadata for updates.

4.4. Conceptual design of the updating process based on the current prototype of Dutch National Atlas (3rd edition)

In the previous paragraph, the general situation of the updating process of National Atlas maps is described. The conceptual design of an updating process that was set up for general situation is slightly different than the set up of this process for the practical case. The practical case is based on the current prototype of Dutch National Atlas (3rd edition). The current prototype doesn't have any function for update processes. The remainder of this research will concentrate on an update checker programme that checks the metadata for updates. For this there is a need to access the metadata and new geospatial data sets. It can be done through standardised interface to CSW and interface to WFS respectively. They have functions to communicate with update checker, the update checker communicates with the metadata (through CSW) and the data sets (through WFS). In catalog service the main attention goes to data metadata only (containing metadata descriptions), we will not focus on a service catalog in this research. As mentioned before, a National Atlas can be considered as an another node of GDI, but for this practical case internal data (e.g. base map files, descriptive text, images, charts) are stored at the atlas server. Also metadata of the internal data is not stored in a standardised data catalog at present; it is maintained in XML files and databases, stored at the atlas server that contain descriptions of design templates as well. Our update checker programme communicates with the GDI components through interfaces to services (a Web Feature service (WFS), in this practical case using GetCapabilities request (Capabilities XML), DescribeFeatureType requests (XML Schema) and GetFeature requests (GML). The update process will be done using the same scenario that is described for overall picture of the update process of the ideal situation. Figure 4.5 shows the set up of the update process of the National Atlas maps that is based on the current prototype of Dutch National Atlas (3rd edition), its concept, design strategies and technical implementation have been described in the previous paragraphs.



Interface to services----provides access to GDI data and presents the updated data sets to update cheker;

Update checker programma-----checks for the metadata for updates;

Figure 4.5 Conceptual design of updating process (practical case)

4.5. An update process of National Atlas maps using the scenario's

In the previous paragraphs the whole set up of the update process of National Atlas maps was described. Now we will focus on the process of checking map metadata and data metadata for updates and to use the scenario's to describe an update process of National Atlas maps considering different types of data changes. As mentioned before, in an ideal situation metadata about National Atlas and metadata about data from the data providers should be maintained in catalog services, two sets of metadata from the data providers in GDI and from National Atlas Bureau. There is a separate component called update checker programme in the set up of the update process that checks for the updates. For example if there is a request for a map, the update checker programme checks metadata for the last change or last checking of map design template, which is maintained by National Atlas Bureau, and the last update date of the GDI data. If the last update or last checking dates (in case of map design template) are different, the scenario's would be used to find out what should be changed. The scenario's are written for the design of a (semi) automatic update process flow and are described in chapter 3. Figure 4.6 shows the set up of the checking process for the metadata changes using the scenario's.

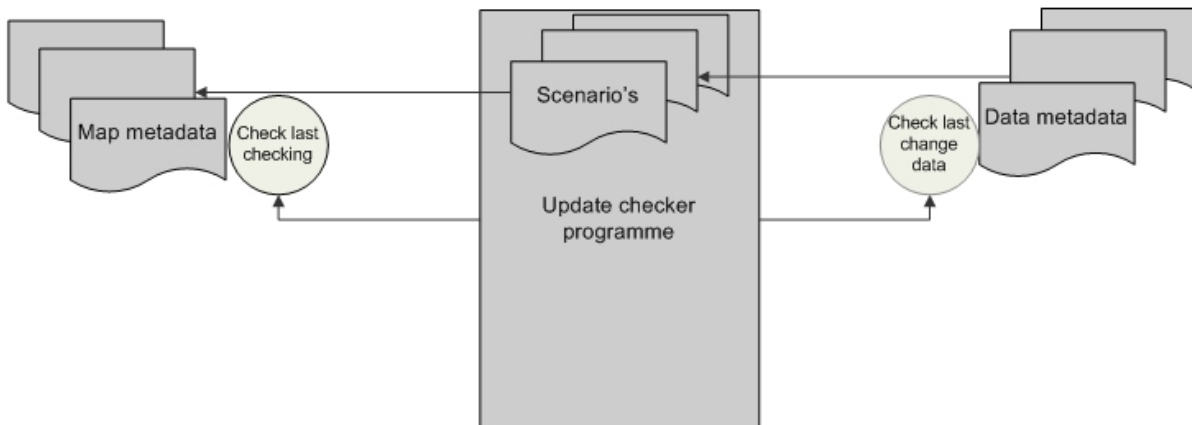


Figure 4.6 Checking process of metadata change using the scenario's

It is important to mention that in this process it is necessary to check the last change of design template and then based on GDI data change to decide if a fully automatic update process or a (semi) automate update process can be done. Based on the scenario's the decision could be made, where human interaction is needed, when there is a need to change map design: in this case the map design template should be changed, which cannot be done without a National Atlas Bureau with staff.

4.5.1. Archival system of National Atlas maps

In the previous chapters it was described how to keep National Atlas up-to-date in GDI environment. This describes the present situation. But sometimes there is a need to get information on the past; this means that it is necessary to have the old data set. But to maintain and display old maps, only the old data set is not enough, the old design templates of maps should be maintained as well. For this there is a need for an archival system, which could be set up based on an agreement between National Atlas Bureau and the data providers. An archival system could be stored on the atlas server side (Kraak, et al., 2000). When users request old map (s) the outdated data sets should be derived from GDI. The old data sets will be maintained by the data providers in GDI. As mentioned above to maintain old maps, old design templates are necessary that will be maintained by National Atlas Bureau. The old design templates will be have to be described in the National Atlas metadata, which should be part of data catalog. To make the archival system more effective, information about valid data of old design templates (e.g. valid from...to...) should be included in metadata about old design templates. The old map(s) could be created and delivered easily using old design templates and old data sets. We can conclude that to have an archival system of National Atlas maps in GDI, it is important to get information on the past, to display old map(s), to compare the various maps in the National Atlas from different years.

4.6. Summary

In the present chapter, we set up a conceptual design of the update process of National Atlas maps in a GDI environment. We described an overall picture of ideal situation, how the conceptual design of update process could be set up. Also we described a set up of a conceptual design for the practical case that is based on the current prototype of Dutch National Atlas (3rd edition). For this reason we described the new concept of the Dutch National Atlas in GDI environment, its design strategies and technical implementation. This chapter presents the updating process of National Atlas maps using scenario's, that focuses on the process of checking map metadata and data metadata for updates and to use the scenario's to describe an update process of National Atlas maps considering different types of data changes. In the whole updating process an important role is played by update checker programme that checks the metadata for updates. In the next chapter we will present a practical implementation of the updating process, how map metadata and data metadata could be stored; how the update checker programme checks map metadata and data metadata and detects last changes of map design templates and actual data sets.

5. Logical design of the updating process of National Atlas in GDI environment

5.1. Introduction

In the present chapter, we will describe the functions that are used by an update checker programme; how it will communicate with the atlas server (using script) and with GDI (using interface to WFS service). How and where map metadata and data can be stored, that will include information about last changes of map design templates and data sets, and also in case of map design template is important to maintain information about last check of design template. The update checker programme checks last changes of map design templates and data sets, detects changes and then compares them. Depending on the changes that will be detected, will be used scenario's, that consider different types of data changes. A server-side scripting language will be used by update checker programme to implement the updating process of National Atlas in a GDI environment.

5.2. National Atlas data metadata

In the previous chapters we have already mentioned, that the updating process will be done based on the current prototype of Dutch National Atlas (3rd edition). The metadata of the Dutch National Atlas maps is maintained in database, stored at the atlas server that contains descriptions of design templates as well. To store the design templates of National Atlas maps, which is part of metadata we use MySQL database. The table called "naexperscript" contains information about design templates of all maps of current prototype, but it doesn't contain information about last change and last check of map design template, since the current prototype doesn't have any function for update processes. For this reason, we inserted new fields "lastchange" and "lastcheck" in the existing table "naexperscript" using server-side PHP script (the code can be found in Appendix A.1.). These fields should be updated after an updating process. In the chapter 3 we described the scenario's for the updating of National Atlas maps. For some of them a (semi) automatic update process is required, for the rest a fully automatic update process can be done. In a (semi) automatic update process some steps should be done by human interaction and at this moment an updating process could be stopped until the atlas editors will carry out the updating process and only after this an updating programme can continue the update process. Based on this we decided to insert a new field "checking by human" in the existing table "naexperscript", containing information when the atlas editors have been involved to change map design template. It can be considered as a piece of atlas metadata as well. The National Atlas Bureau with staff is responsible for maintenance of the metadata of National Atlas data (maps). Figure 5.1 shows an overview of the design template (meta)data of National Atlas, that includes three tables describing the design template of National Atlas maps.

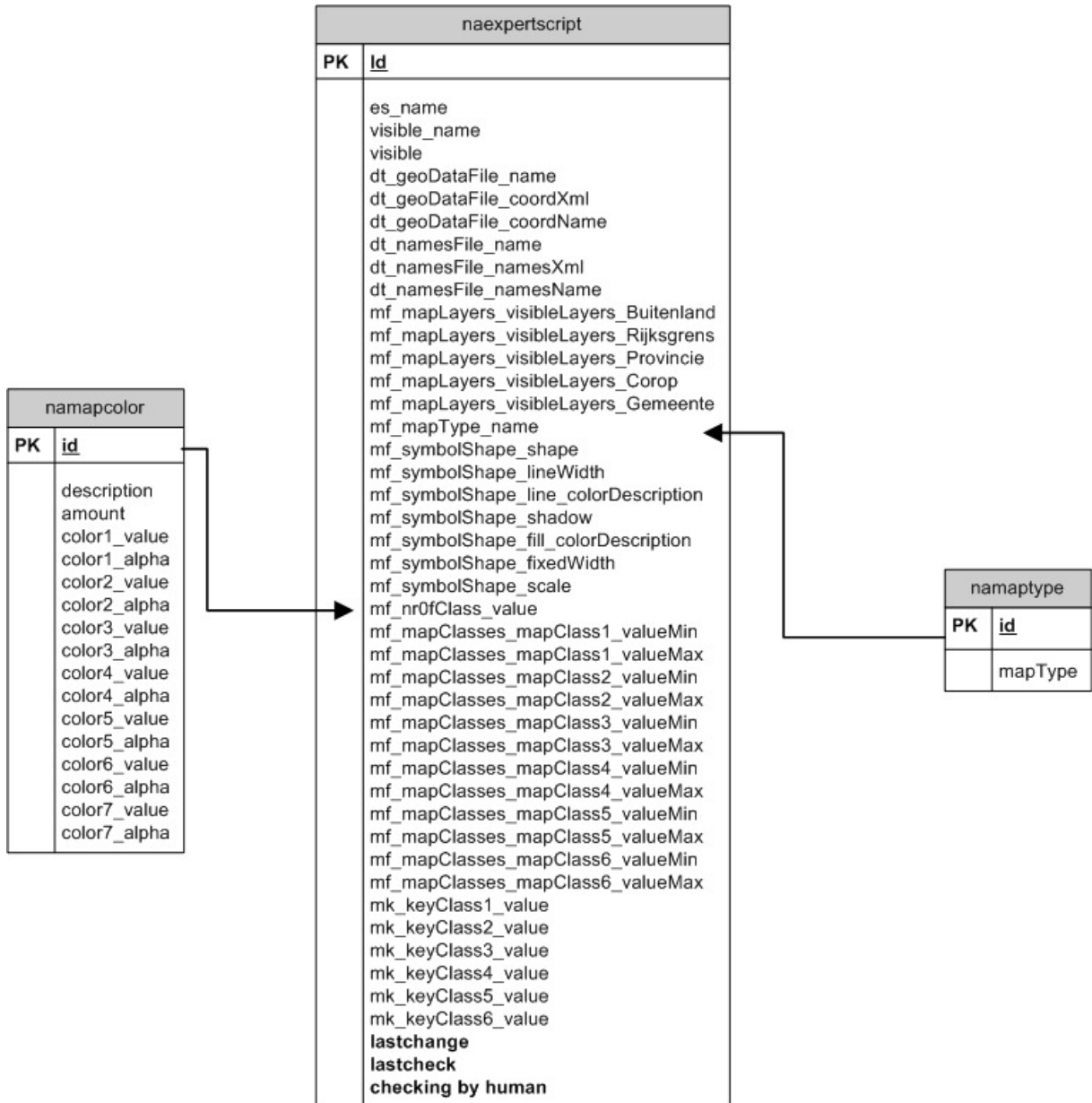


Figure 5.1 An overview of the design template (meta)data

5.3. GDI data metadata

The current prototype of Dutch National Atlas (3rd edition) uses statistical data (CBS) for map creation. The statistical data is stored in tables on a CBS server and through WFS service, using WFS operations (GetCapabilities (in XML), DescribeFeature(XML), GetFeature(GML)) we can get description of feature types in detail and actual feature instances. We focus on the statistical data relevant to "province", "corop", "gemeente". Like map metadata, current GDI data doesn't have information about last changes of data sets. The structure of the statistical data on CBS server is not suitable to include information about last change of data sets, since the statistical data is not stored as a row in the table (it means that it doesn't have

unique id). Figure 5.2 shows part of a GML file that is output of WFS and it contains actual feature instance.

```

<ms:prov>20</ms:prov>
<ms:sum_aant_i>574050.000000</ms:sum_aant_i>
<ms:sum_aant_m>285110.000000</ms:sum_aant_m>
<ms:sum_aant_v>288960.000000</ms:sum_aant_v>
<ms:mean_p_00_>18.0800000000</ms:mean_p_00_>
<ms:mean_p_15_>11.2000000000</ms:mean_p_15_>
<ms:mean_p_25_>26.3200000000</ms:mean_p_25_>
<ms:mean_p_45_>28.6400000000</ms:mean_p_45_>
<ms:mean_p_65_>15.5600000000</ms:mean_p_65_>
<ms:mean_p_wes>5.7200000000</ms:mean_p_wes>
<ms:mean_p_n_w>3.3200000000</ms:mean_p_n_w>
<ms:mean_p_mar>0.08000000000000</ms:mean_p_mar>
<ms:mean_p_ant>0.20000000000000</ms:mean_p_ant>
<ms:mean_p_sur>0.44000000000000</ms:mean_p_sur>
<ms:mean_p_tur>0.44000000000000</ms:mean_p_tur>
<ms:mean_p_ove>1.76000000000000</ms:mean_p_ove>
<ms:sum_aantal>269450.000000</ms:sum_aantal>
<ms:mean_p_eeen>29.4000000000</ms:mean_p_eeen>
<ms:mean_p_hh_>33.4400000000</ms:mean_p_hh_>
<ms:mean_p_hh1>37.2000000000</ms:mean_p_hh1>
<ms:sum_woning>247735.000000</ms:sum_woning>
<ms:mean_woz>149.8000000000</ms:mean_woz>
<ms:mean_bev_d>317.1600000000</ms:mean_bev_d>
<ms:sum_opp_la>233327.000000</ms:sum_opp_la>
<ms:sum_opp_to>296003.000000</ms:sum_opp_to>
<ms:sum_wwb_ui>16780.00000000</ms:sum_wwb_ui>
<ms:mean_p_wwb>46.2400000000</ms:mean_p_wwb>
<ms:sum_ao_uit>32730.00000000</ms:sum_ao_uit>
<ms:mean_p_ao_>91.9600000000</ms:mean_p_ao_>
<ms:mean_p_ind>21.3200000000</ms:mean_p_ind>
<ms:mean_p_com>57.0800000000</ms:mean_p_com>
<ms:mean_p_n_c>21.5200000000</ms:mean_p_n_c>
<ms:sum_agra_b>3540.00000000</ms:sum_agra_b>
<ms:prov_naam>Groningen</ms:prov_naam>

```

Figure 5.2 GML file, output of WFS of CBS service

There are several ways to change the structure of data set. We decided to transpose existing tables into new tables that are maintained on the atlas server. A new database in MySQL and new tables (CBS data per province, per crop and gemeente) in this database have been created and populated with statistical data using GetFeature request, which returns actual feature instances (see Figure 5.3), (the codes can be found in Appendix A.2.). In the new tables a field “lastchange” is included, that contains information about last changes of data sets. It is part of data set metadata and should be maintained by data providers.

| ID | CBS | Groningen | Friesland | Drente | Overijssel | Flevoland | Gelderland |
|----|--|----------------|-----------------|----------------|----------------|----------------|-----------------|
| 1 | Aantal inwoners per provincie | 574050.000000 | 642220.000000 | 484490.000000 | 1113540.000000 | 370660.000000 | 1975740.000000 |
| 2 | Aantal mannen per provincie | 285110.000000 | 320590.000000 | 239540.000000 | 556110.000000 | 185120.000000 | 975000.000000 |
| 3 | Aantal vrouwen per provincie | 288960.000000 | 321620.000000 | 239540.000000 | 557410.000000 | 185550.000000 | 1000720.000000 |
| 4 | Aandeel 0-14 jarigen per provincie | 18.0800000000 | 19.2258064516 | 18.3333333333 | 20.1200000000 | 24.0000000000 | 19.3035714286 |
| 5 | Aandeel 15-24 jarigen per provincie | 11.2000000000 | 11.1612903226 | 10.1666666667 | 11.9200000000 | 13.6666666667 | 11.3214285714 |
| 6 | Aandeel 25-44 jarigen per provincie | 26.3200000000 | 26.8709677419 | 25.7500000000 | 27.3600000000 | 29.6666666667 | 27.3035714286 |
| 7 | Aandeel 45-64 jarigen per provincie | 28.6400000000 | 27.6129032258 | 28.9166666667 | 26.0400000000 | 23.0000000000 | 27.3392857143 |
| 8 | Aandeel 65+ ers per provincie | 15.5600000000 | 15.1612903226 | 16.7500000000 | 14.4800000000 | 9.3333333333 | 14.7678571429 |
| 9 | Aandeel westerse alloctonen per provincie | 5.7200000000 | 4.45161290323 | 4.8333333333 | 5.6400000000 | 6.5000000000 | 6.83928571429 |
| 10 | Aandeel niet-westerse alloctonen per prov | 3.3200000000 | 2.45161290323 | 2.5000000000 | 4.2800000000 | 10.0000000000 | 4.44642857143 |
| 11 | Aandeel Marokkanen per provincie | 0.080000000000 | 0.129032258065 | 0.166666666667 | 0.120000000000 | 1.500000000000 | 0.625000000000 |
| 12 | Aandeel Antillanen per provincie | 0.200000000000 | 0.161290322581 | 0.000000000000 | 0.160000000000 | 0.833333333333 | 0.0535714285714 |
| 13 | Aandeel Surinamers per provincie | 0.440000000000 | 0.161290322581 | 0.166666666667 | 0.160000000000 | 3.166666666667 | 0.303571428571 |
| 14 | Aandeel Turken per provincie | 0.440000000000 | 0.0967741935484 | 0.250000000000 | 1.920000000000 | 1.000000000000 | 1.19642857143 |
| 15 | Aandeel overige niet-west allocht per prov | 1.760000000000 | 1.58064516129 | 1.58333333333 | 1.840000000000 | 3.500000000000 | 1.750000000000 |
| 16 | Aantal huishoudens per provincie | 269450.000000 | 274340.000000 | 202150.000000 | 461380.000000 | 147250.000000 | 826680.000000 |
| 17 | Aandeel 1-persoonshuishoudens per provincie | 29.4000000000 | 30.4193548387 | 27.5833333333 | 26.4800000000 | 25.6666666667 | 27.0178571429 |
| 18 | Gemiddelde WOZ-waarde van woningen per p... | 149.8000000000 | 171.0000000000 | 191.3333333333 | 203.7200000000 | 187.0000000000 | 236.714285714 |
| 19 | Bevolkingsdichtheid per provincie | 317.1600000000 | 259.322580645 | 252.4166666667 | 451.8400000000 | 580.5000000000 | 542.8750000000 |
| 20 | Aandeel industrie per provincie | 21.3200000000 | 23.5806451613 | 18.7500000000 | 21.9200000000 | 20.5000000000 | 21.0000000000 |
| 21 | Aandeel commerciële dienstverlening per prov | 57.0800000000 | 57.6451612903 | 59.3333333333 | 60.2800000000 | 61.5000000000 | 59.9821428571 |
| 22 | Aandeel niet-comm dienstverlening per prov | 21.5200000000 | 18.7741935484 | 21.7500000000 | 17.8400000000 | 17.8333333333 | 18.9642857143 |

Figure 5.3 Statistical data per province, transposed from the original table

5.4. An update checker programme checks and detects last change

In the previous paragraphs we described how map metadata and data metadata could be stored and maintained. The next step is how an update checker programme can check and detect last changes of map design template and data sets. The update checker programme use a server-side scripting language (in our case: PHP) to communicate with atlas server and GDI data, to check and detect last changes. In this chapter we use pseudocode (instead of complete and fully implementable PHP code) to outline the general steps of the updating process. The pseudocode below show how update checker programme can detects last changes of map design template and datasets.

```

\\ check last change of map design template

class lastchange {
    function getlastchange(name of a map) {

        $db_name= "natatlas";
        //connect to database using database location; database
        username; database password
        //get lastchange date from database (SELECT all fields

```



```
        FROM table:"naexpertsript" WHERE a record="name of a
        map")
        //get query result
        // if query is successful
        // --print success message
        // if failed
        // --print error message
        // disconnect from database
    }
}
```

\\ check last change of GDI dataset

```
class lastchangeds {
    function getlastchange(name of a dataset) {

        $db_name= "test";
        //connect to database using database location; database
        username; database password
        //get lastchange date from database(SELECT all fields
        FROM table: "province" WHERE a record="name of a
        dataset")
        //get query result
        // if query is successful
        // --print success message
        // if failed
        // --print error message
        // disconnect from database
    }
}
```

After the update checker programme checks last changes and gets information about the dates of last changes, it is necessary to compare two metadata sets (map metadata and data metadata), for this the following code has been written.

```
class comparelastchange {
    function getcomparisonlastchange(name of a map; name of a
        dataset; ) {

        $db_name= "natatlas"; "test";
        //connect to database using database location; database
        username; database password
        //get information from database(SELECT fields:"es_name",
        "lastchange"FROM table:"naexpertsript" WHERE a record="name
        of a dataset)
        union all
        //get information from database(SELECT fields:"CBS", "lastchange"
        FROM table:"province" WHERE a record="name of a dataset);
        //get query result
        // if query is successful
        // --print success message
        // if failed
        // --print error message
        // disconnect from database
    }
}
```

The examples of full PHP version of these pseudocodes can be found in Appendix A.3.

5.4.1. An updating programme performs the updating process using the scenario's

If the last update or last checking dates (in case of map design template) are different the updating programme uses the scenario's for updating process. In the chapter 3 we have already described 5 scenario's using different map types and different types of data change. We will describe all of the scenario's and each steps, how they could be done in the updating process of National Atlas maps.

In the scenario's 1 and 2 choropleth maps are used. The changes of the statistical data are slightly different, in both cases upper number of class boundary is changed, but difference is that there is no significant change in case of the scenario 1 (only the first and the second class boundaries are changed). Data is changed significantly in the scenario 2, this means all class boundaries are changed. After detailed analysis of both scenario's , we concluded that their implementation in the updating process could be done using the same codes, only small differences would be in the piece of code for updating of the table (less fields of the table would be updated in case of the scenario1). The following code is written where we set up a case in our script which is executed depending on "GET" parameters, it is for getting data from databases from CBS server and atlas server. We then take each row from our results to compare the last changes of datasets from CBS server and atlas server.

```
// extract value of a statistical dataset from CBS server

$USERNAME = ''; //database username
$PASSWORD = ''; //database password
$DATABASE = ''; //database name
$URL = ''; //database location

//get a statistical dataset from table"province"(CBS server)
if(isset(GET['getprovince(CBS)']))
{
    $db_name= "natatlas";

//connect to database using database location; database username;
database password
    or die('Cannot connect to database.');
```

```
//return an array of the values of dataset

$returnArray1 = array();

//get information from database
    query = 'SELECT datasetname FROM province(CBS)';

//get query result
    result = '_query(query);

//take each row from our results and add each of them to the
    "returnArray"
while(row = '_fetch_assoc(result))
```

```
{
array_push(returnArray, row);
}
// if query is successful
    // --print success message
    // if failed
    // --print error message
    // disconnect from database
}

//extract value of a statistical dataset from atlas server
//get a statistical dataset from table"province"(atlas server)
    if(isset(GET['getprovince']))
    {
$db_name= test
//connect to database using database location; database username;
database password
    or die('Cannot connect to database.');
```

```
//return an array of the values of dataset

    returnArray2 = array();
//get information from database
    query = 'SELECT* FROM province WHERE WHERE a record='name of a
    dataset'
//get query result
    result = '_query(query);

//take each row from our results and add each of them to the
"returnArray"
    while($row = '_fetch_assoc(result))

    {
array_push(returnArray, row);
}

// if query is successful

// --print success message
// if failed
// --print error message
// disconnect from database
    }
}
```

The examples of PHP version of these pseudocodes can be found in Appendix B.1. The next step is to make the decision about class boundaries: "Can existing class boundaries be maintained or not?" (see the following code).

```
if ('array1')!= ('array2')
```

```
print 'Class boundaries are changed!'
else
    print 'Class boundaries are not changed!'
```

Based on data changes the decisions are made that no human interaction is needed in the updating process, fully automatic update process can be done. The next steps are to update the class boundaries and a text in map legend. It is important to mention , that map design is not changed, it means that there is no need to update the field “lastchange” in atlas metadata, but “lastcheck” would be updated (the codes can be found in Appendix B.2.).

In the scenario 3 we use a choropleth map, statistical data is changed: data range is changed. In this scenario a (semi)automatic update process is used. Based on decisions have been made, some steps should be done by human interaction (e.g. choose appropriate classification method) and some of them can be done automatically. The updating programme checks a data range of a particular statistical dataset on CBS server and also checks a data range of the same statistical dataset that is maintained on atlas server (the codes can be found in Appendix C.1.).

The dataset requires an updating, since the data ranges aren't equal and an appropriate classification method should be chosen, that can't be done automatically, there is a need of human interaction (see the following code).

```
if ('range1')!= ('range2')
    print 'New classification method is required!'
        'A message should be sent to the National Atlas bureau and
        ask to chose an appropriate classification method!'
else
    print 'The same classification method is used!'
```

The message will be sent to National Atlas Bureau and the atlas editors will make a decision based on the data which classification method can be used. At this stage we made decision that to choose appropriate classification method requires a human interaction. It is important to mention that the roles (of human and computer) are not fixed in the update process. It is flexible process. For example, in the future it might be possible to choose appropriate classification method automatically, since someone will be able to add new functions for it. (In detail about cooperation of automatic part of system and human part of bureau will be discussed in chapter 6).

After the atlas editors have made decision which classification method should be used the updating process can be continued by the updating programme. The next step of the updating process is to change class boundaries, for this the following pseudocode has been written (the example of PHP version of this pseudocode can be found in Appendix C.2.):

```
//update table "naexpertsript"
$db_name= "natatlas";

//connect to database using database location; database username;
database password

    or die('Cannot connect to database.');
```



```
'_select_db("natatlas", con);

//update the fields of table "naexpertsript"

'_query("UPDATE naexpertsript SET mf_mapclasse1_valueMin = 'new
        value', mf_mapclasse1_valueMax= 'new value',
        mf_mapclasse2_valueMin = 'new value',
        mf_mapclasse2_valueMax= 'new value'
WHERE name of filed= 'name of a map'");

//get query result
// if query is successful
// --print success message
// if failed
// --print error message
// disconnect from database
    }
}
```

According to the scenario the next change will be in map legend, a text in the map legend will be changed. To perform the updating process of the text in the map legend the following pseudocode was written (the example of PHP version of this pseudocode can be found in Appendix C.2.):

```
//update table "naexpertsript"
$db_name= "natatlas";

//connect to database using database location; database username;
database password

    or die('Cannot connect to database.');
```



```
'_select_db("natatlas", con);

''_query("UPDATE naexpertsript SET mk_keyclaas1_value = 'new
        value', mk_keyclaas2_value = 'new value',
        mk_keyclaas3_value = 'new value',mk_keyclaas4_value=
```

```
        'new value',mk_keyclaas5_value='new value');  
//get query result  
// if query is successful  
// --print success message  
// if failed  
// --print error message  
// disconnect from database  
    }  
}
```

After all the changes and the updating have been done, the last stage of the updating process of the scenario 3 is map design changes that mean that a map design template is changed. It is required to update the fields “lastchange” and “lastcheck” in atlas data metadata (the codes can be found in of Appendix C.3.).

In the scenario 4 a choropleth map is used; data is changed: administrative units are changed (e.g. a province is split), it means that a number of provinces is increased (a new province is appeared). Based on data changes it is obvious that geography and attribute information are changed, the decisions have been made that these steps should be done by human interaction. Considering these changes, the decision has been made that the existing class boundaries and map legend could not be maintained, for this automatic update process can be carried out. The first step for the updating process is that an updating programme connects to CBS server and requests a particular dataset; also it requests the same dataset from atlas server (the code can be found in Appendix D.1.).The dataset on atlas side needs an updating since data is changed (a province is split). At this stage of the updating process human interaction is needed (see the following code).

```
if ('array1')!= ('array2')  
    print 'Geography and attribute information are changed !'  
    'Send message to National Atlas bureau to change an  
    existing geography (a province is split)!'  
else  
    print 'Geography and attribute information are not changed !'
```

The message will be sent to National Atlas Bureau, where an existing geography will be changed by a cartographer (or the atlas editors), based on this the field “checking by human” in “naexpertsript” table will be updated. Attribute information is related to a geography changes can be updated automatically without human interaction. It is important to mention that a new field for new province should be added in “province” table on atlas server side. An updating programme will perform the next steps of updating process (class boundaries and map legend are changed). Considering all the changes we can conclude that map design is changed. For this reason the fields “lastchange” and “lastcheck” will be updated (the codes can be found in Appendix D.2.).

In the scenario 5 we presented a graduated point symbol map; Statistical data is changed: Absolute number of population is increased. Based on data changes ,the decision is made that size of graduated rectangle symbols are changed. Considering data change another decision is made, that fully automatic update process can be done. As in case of the previous scenario's, the first step for updating process is that required dataset will be extracted from CBS server and from atlas server by an updating programme (the codes can be found in Appendix E.1.). The dataset that is maintained in database on atlas server requires the updating (see the following code).

```
if ('array1')!= ('array2')
    print 'Size of symbols are changed!'
else
    print 'Size of symbols are not changed!'
```

The next step of the updating process is to change size of symbols. The class boundaries and map legend are changed as well. For this reason the fields in “naexperscript” table should be updated (fields that contain appropriate information for updating process), also the field “lastcheck” will be updated (the codes can be found in Appendix E.2.).

5.5. Summary

In the present chapter we described how the implementation of the updating process could be done , how could National Atlas data metadata and GDI data metadata be maintained, since the metadata plays a significant role in a updating process in general and specifically in the updating process of National Atlas maps. An update checker programme is important component of the set up of the updating process. It checks and detects last changes and last check (in case of map design template) of map design template and dataset. An update checker programme contains the functions for a (semi) automatic and fully automatic updating that are performed by an updating programme. It executes the updating process using the scenario's for different types of map and different types of data changes, which we described step by step for all scenario's that have been set up.

6. Results, testing

6.1. Introduction

The results of this research will be considered in this chapter: First we designed a (semi) automatic update workflow for different map types and data change in which a National Atlas Bureau with staff should be involved. Based on these update workflow, there is a clear picture about which part of this process can be done fully automatically and which part requires a human interaction. Secondly we set up a conceptual design of the update process that described an overall picture of ideal situation, how the conceptual design of update process can be set up ideally, and also we presented a conceptual design of the update process for the practical case, which is based on the current prototype of Dutch National Atlas (3rd edition). We presented an implementation of the conceptual design of the update process for a practical case, in a logical design for our 5 scenarios. It is important to introduce the concept and design the set up how to maintain the metadata of National Atlas data and GDI data for the updating process, which is done in this research. An updating checker programme has been introduced by us that takes care of the updating process of National Atlas maps in a GDI environment.

We determined the role of National Atlas Bureau in a (semi) automatic update process workflow. Based on this research, we can conclude there is a need of a human interaction in the update process, but also it is obvious that the tasks of National Atlas Bureau are not fixed, they could be changed.

In this chapter we will report the results achieved as well as limited testing of the conceptual and logical design, that we performed by actually implementing a physical design using the scenario 3 for the updating process and testing it.

We should mention that we don't have any evaluation of the updating process with respect to usability testing, since we added some updating functions to the current prototype of Dutch National Atlas (3rd edition), this means that we didn't work on end-user side. It is therefore logical that no usability research has been carried out by us.

6.2. How is the updating process of National Atlas maps performed?

In the introduction we have already mentioned, that as the results of this research can be considered:

- design of a (semi) automatic update workflow
- set up of a conceptual design of the update process (an overall picture of ideal situation)
- set up of a conceptual design of the update process for the practical case
- logical design of the updating process
- implementing a physical design of part of the updating process

An implementation of a logical design and a physical design of part of the updating process based on the results, we achieved in the design part of the research. At the step of design of a (semi) automatic update workflow we proposed 5 scenario's for different map types that include several cases of statistical data changes and give a clear picture of the tasks of National Atlas Bureau with staff, how and in which cases they could be involved in the updating process. This step is very important for the whole updating process since the results of this step are included in the logical design of the updating process.

The implementation of the updating process would not be done properly, without set up a conceptual design of the updating process. For this reason we proposed a conceptual design of the updating process for an ideal situation and for the practical case. The latter is used for the implementation of the updating process in this research. It is based on the current prototype of Dutch National Atlas (3 rd edition). To implement a conceptual design of the updating process for ideal situation will be one of our recommendations that we will propose in the next chapter.

National Atlas data metadata and GDI data metadata are important components in the updating process in order to maintain information about last change of map design template and dataset. There were several options for maintenance of such information. As we described in the chapter 4, we added new fields to tables (tables for map design template and for statistical data) that contain information about last changes. We maintained the metadata of map design templates and statistical datasets on atlas server. An updating checker programme is the key component in the whole updating process of National Atlas maps, it runs on atlas server. It checks and detects last changes and last check of map design template and statistical dataset. The checker programme contains the functions for a (semi) automatic or fully automatic updating process. An updating programme performs the updating process using the scenario's that have been designed by us.

In this paragraph we described how the updating process of National Atlas maps is performed and based on it ,we can conclude that the results that have been achieved in this research, very much related to each other and the implementation of the updating process is based on those results. The next step is an implementation of a physical design of part of the updating process of National Atlas maps.

6.3. Physical design of the updating process

We performed limited testing of the conceptual and logical design of the updating process, by implementing a physical design using the scenario 3 and testing it. In chapter 5 we described the logical design of the updating process. Pseudocodes are used to describe the steps of the updating process for all scenario's. The same steps are taken to implement a physical design using PHP code (server-side scripting language). Figure 6.1 shows the steps, PHP code and the results of the updating process.



Figure 6.1 Physical design of the updating process

(as can be tested on the website: [http:// geoserver.itc.nl/NatAtlas/updatechecker/](http://geoserver.itc.nl/NatAtlas/updatechecker/))

6.4. The role of National Atlas Bureau in the updating process

The National Atlas Bureau with staff plays a significant role in a design process of National Atlas maps. It is responsible to create well designed maps using map design templates. To keep National Atlas maps up-to date in a GDI environment is very important. Based on data changes an update process can be automated, but in some cases a human interaction is necessary. It is important to maintain well designed maps through an updating process. National Atlas Bureau should be involved in this process. It has responsibilities to maintain National Atlas data metadata, which is very important in the updating process. National Atlas data metadata describes map design template and also it includes information about last change and last check of map design templates that are used by an update checker programme to perform the updating process.

As we state in chapter 3, a (semi) automatic update process workflow has been designed by us using the scenario's for different map types and different data changes. We interviewed people who are involved in atlas production and discussed the scenario's with them, based on corrections have been made by them the scenario's have been improved. We can say that the conceptual design and the scenario's have been validated with the opinion of the experts.

According to the examples used in the scenario's, we have a clear picture where a human interaction is needed in the updating process. For example, when administrative boundaries

have changed (e.g. provinces have merged or split), resulting in geometry changes, this means that a new geometry file is required. In this case the updating process can't be done fully automatically here is a need of human interaction in this process. In the scenario 3 we have an example when data range is changed (strong increase or decrease of statistical data) According to this the decision has been made about new (appropriate) classification method choosing, that should be done by a human. But we would like to stress here that these decisions are not fixed, they are flexible, since for example, new functionality might be added for automatically classification method choosing. This means that this process can be automated later. We would like to have an update process as automate as possible; in this case it will be much proper in GDI node and much quicker to react to changes. But at the same time we believe that there are some cases in an update process that needs a human interaction. As we stated before this process is flexible, the roles can be changed between an automatic part of system and a human part of National Atlas Bureau.

We have already explained how a system can detect the fact that the data has changed. But the system doesn't go too much into actual change detection. It is important to think how the system can detect data changes and what exactly has been changed. This is not easy task for some cases. For example, when a municipality is split, the system says that data is changed and a municipality is split, in fact somewhere it should be detected. It is obvious that this fact is not so easy to detect automatically, how the system knows that there is a new municipality. For this reason there is a need to have proper metadata. Data providers should provide proper metadata and this will have to include lineage. To detect such hard cases (e.g. split of a municipality) by a system automatically requires a lot of work on data providers side. As long as data providers don't have metadata to detect data change automatically, it will be a human decision in this case, this means that the roles can be changed between a system and a human. Again we like to highlight that the decisions have been made in the updating process are not fixed, and also any system will be built will be depending on good metadata, on quality of metadata.

7. Conclusion and recommendations

7.1. Integration of National Atlas and GDI in terms of the updating process of National Atlas maps

One of the objectives of this research was to describe the possibilities for a (semi) automatic updating process of National Atlas maps from GDI data. To achieve this goal, we needed better understanding of the concept of National Atlas and GDI. For this reason we set up the following research questions: "What is a National Atlas?" and "What is a Geospatial Data Infrastructure?" The review we did on the concept of National Atlas and GDI helped us to answer these research questions.

To determine the possible role of a National Atlas Bureau in the updating process was important for our research. Accordingly one of the goals of this research was to understand and examine the role and responsibilities of a National Atlas Bureau in map design process and specifically in the updating process of National Atlas maps. We achieved this goal partially by literature review and by interview people who have been involved in the Dutch National Atlas Bureau. To establish the tasks of National Atlas Bureau in the updating process, a (semi) automatic update workflow was designed by us that will be discussed in the next paragraph.

This research is based on the current prototype on The Dutch National Atlas (3rd edition) (it has been described in chapter 4). The Current prototype has been examined in this research, we interviewed people who have been involved in creating this prototype and based in this investigation and also on the examination of the role of National Atlas and GDI, we determined how the datasets available from national data providers can be visualized according to map design templates.

7.2. Designing a (semi) automatic update workflow and a conceptual design of the updating process

This research tries to emphasize the role of a National Atlas Bureau in the updating process of National Atlas maps in a GDI environment, since we believe that in order to maintain well designed maps, a human interaction is necessary in the update process. To achieve this goal we described the possibilities for a (semi) automatic update process of National Atlas maps from GDI data. For this reason a (semi) automatic update process workflow has been designed by us. It is obvious that better to have a system for the update process as automated as possible, but there are some cases when a human interaction is necessary in this process. We set up the scenario's for a (semi) automatic update process workflow to show where a National Atlas Bureau with staff should be involved in the update process and where this process can be performed by a system. Based on this we determined the possible role of a National Atlas Bureau in the update process. It is important to stress again

(as we discussed in chapter 6) that the decisions made by a human and by a system are flexible, they can be changed.

In order to find out how the update process works, a conceptual design of an updating process for ideal situation and for practical case has been set up. The practical case is used for the implementation of the updating process of National Atlas maps. According to the objectives and research questions we designed a conceptual design of an update process in such a way, that our system is concentrated on how to detect data changes. In order to describe how the update process can influence a map design (e.g. how symbologies, similar class boundaries, legend colors can be maintained) the system includes the actual updating programmes that have functions for fully automatic update process and for a (semi) automatic update process.

7.3. Logical and physical design of the updating process

As we have already mentioned in chapter 5 an update checker programme plays important role in the update process. There is a need to have well organized metadata for National Atlas and for GDI data since an update checker programme uses metadata to perform the update process. We maintained information about last changes and last checking in atlas data metadata and datasets metadata that are used by an update checker programme to check and detect last changes of map design templates and datasets.

The update process of National Atlas maps is performed using a server-side scripting language. An implementation of the conceptual design of the update process for a practical case, in a logical design for our 5 scenario's has been done, and also limiting testing has been performed to implement a physical design using the scenario 3 for the updating process.

7.4. Recommendations

In this research we described 5 scenario's for a (semi) automatic updating process using only two types of map (choropleth and proportional point symbol map) and considering different types of data changes; but of course more examples could be included and used in the scenario's in order to get broader overview of the picture for the updating process of National Atlas maps in a GDI environment.

We set up a conceptual design of the updating process for ideal situation. We would propose to use this conceptual design for update of National Atlas maps in a GDI environment in the future. Based on this conceptual design, metadata can be maintained in catalog service that contains data catalog (with data metadata) and service catalog (services data metadata). An update checker programme will check and get information about last changes of GDI datasets and National Atlas map design templates through catalog service using standardising metadata. We believe, that National Atlas can be treated as a GDI node,

it means that National Atlas will be considered one of the many GDI services. Correspondingly National Atlas data metadata should be found in data catalogs and National Atlas service metadata in service catalogs. Using Catalog services for the maintenance of metadata and National Atlas as a GDI node, the updating process can be performed effectively.

We had planned to test how the update programme performs the updating process using the scenario's, but because of time limitations, this was unfortunately very limited. We would propose to test how the update programme works using all the scenario's for different map types and for different types of data changes.

In this research we used an update checker programme for the update process. We learned from literature about agent technology that looks very promising to use it in an update process of National Atlas maps in a GDI environment. An agent is a computer system, that has a capability for flexible autonomous action in order to meet its design objectives (Kraak, et al., 2000). We think that our conceptual design of the update process can be incorporated into such a system. We propose to use a multi-agent based system to perform the updating process of National Atlas maps. This system uses different types of agents. They perform the tasks in a multi-agent system framework. The agents communicate with each other to perform the updating process. The update process can be done based on the metadata and using a multi-agent based system. Once again, we think that this system looks very promising and we would recommend using it for the update process of National Atlas maps in a GDI environment.

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Appendix A

A.1. Insert new fields in the existing table

```
// insert new filed in existing mysql table
<?php
$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

mysql_query("INSERT INTO naexpertsript (lastchange)
VALUES ('10.08.2009')");

mysql_query("INSERT INTO naexpertsript (lastcheck)
VALUES ('07.06.2009')");

mysql_close($con);
?>
```

A.2. Create new database and table

```
<?php
$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

if (mysql_query("CREATE DATABASE test",$con))
{
echo "Database created";
}
else
{
echo "Error creating database: " . mysql_error();
}

mysql_close($con);

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}
```

```
if (mysql_query("CREATE DATABASE test",$con))
{
echo "Database created";
}
else
{
echo "Error creating database: " . mysql_error();
}

// Create table
mysql_select_db("test", $con);
$sql = "CREATE TABLE province
(
ID int,
CBS varchar(50),
Groningen varchar(50),
Friesland varchar(50),
Drente varchar(50),
Overijssel varchar(50),
Flevoland varchar(50),
Gelderland varchar(50),
Utrecht varchar(50),
Noord-Holland varchar(50),
Zuid-Holland varchar(50),
Zeeland varchar(50),
Noord-Brabant varchar(50),
Limburg varchar(50),
lastchange varchar(50)
)";

Insert Into CBS VALUES ('Aantal inwoners per provincie',
574050.000000, 642220.000000, ....);
Insert Into CBS VALUES ('Aantal mannen per provincie',
285110.000000, 320590.000000, ....);
Insert Into CBS VALUES ('Aantal vrouwen per provincie',
288960.000000, 321620.000000, ....);
// Execute query
mysql_query($sql,$con);

mysql_close($con);
?>
```

A.3. Check and detect last changes of map design template and datasets

```
<?
function
getlastchange($db_name,$tablename,$fieldnameselect,$wherePart) {
    $connection=mysql_connect("localhost", "root",
"****");
    mysql_select_db($db_name, $connection);
    $query="SELECT $fieldnameselect FROM $tablename $wherePart
";
    $q_result=mysql_query($query);
```

```
        if (!$q_result) {
            echo "Could not run query: [" . $query . "] error is: " .
mysql_error();
            exit;
        }
        $row = mysql_fetch_row($q_result);
        mysql_close();
        return $row[0];
    }
}
```

```
$datechangeofatlasbureautable= getlastchange("test","province",
"lastchange", "WHERE CBS LIKE 'Aandeel 15-24jarigen per
provincie'");
$datechangeofCBStable= getlastchange("natatlas","provincie_tmp",
"lastchange", "");
$datechangeoftemplate= getlastchange("natatlas","naexpertsript",
"lastchange", "WHERE es_name LIKE 'pctLeeft15_24prov'");
```

```
echo 'the result is: <br>';
```

```
echo "the last change date of atlas bureau table is: " .
$datechangeofatlasbureautable . "<br>";
echo "the last change date of CBS data is: " .
$datechangeofCBStable . "<br>";
echo "the last change date of design template is: " .
$datechangeoftemplate . "<br>";
```

```
if ($datechangeofatlasbureautable != $datechangeofCBStable) {
    echo "data is changed";
} else {
    echo "data is not change";
}
```

```
if ($datechangeofatlasbureautable < $datechangeofCBStable) {
    echo "data is changed";
} else {
    echo "data is not change";
}
```

```
if ($datechangeofatlasbureautable > $datechangeofCBStable) {
    echo "something is wrong";
} else {
    echo "data is changed";
}
```

```
?>
```

Appendix B

Scenario 1; Scenario 2;

B.1. Get datasets from CBS server and atlas server

```
// extract statistical dataset from CBS server

<?
$USERNAME = 'nâtâtlas'; //database username
$PASSWORD = '****'; //database password
$DATABASE = 'natatlas'; //database name
$URL = 'pubnl03.itc.nl'; //database location

if(isset($_GET['getprovince(CBS)']))
{
pgsql_connect($URL, $USERNAME, $PASSWORD);
pgsql_select_db($DATABASE) or die('Cannot connect to database.');
```

\$returnArray1 = array();

```
$query = 'SELECT datasetname FROM province(CBS)';
$result = pgsql_query($query);

while($row = pgsql_fetch_assoc($result))
{
array_push($returnArray, $row);
}

pgsql_close();
echo json_encode($returnArray);

// extract a statistical dataset from atlas server

if(isset($_GET['getprovince']))
{
$db_name= natatlas
    $connection=mysql_connect("localhost", "root", "****")
    $selection=mysql_select_db($DATABASE) or die('Cannot
connect to database.');
```

\$returnArray2 = array();

```
    $query="SELECT* FROM province WHERE es_name LIKE
'$datasetname
    $result = mysql_query($query);

while($row = mysql_fetch_assoc($result))
{
array_push($returnArray, $row);
}

mysql_close();
echo json_encode($returnArray);
```

```
}  
?>
```

B.2. Update class boundaries and text in map legend

```
// update table "naexpertsript"  
  
<?  
  
$con = mysql_connect("localhost","root","****");  
if (!$con)  
{  
die('Could not connect: ' . mysql_error());  
}  
  
mysql_select_db("natatlas", $con);  
  
mysql_query("UPDATE naexpertsript SET mf_mapclasse1_valueMax= 'new  
value',  
mf_mapclasse2_valueMin = 'new  
value', mf_mapclasse2_valueMax= 'new value'  
mf_mapclasse3_valueMin = 'new  
value', mf_mapclasse3_valueMax= 'new value'  
mf_mapclasse4_valueMin = 'new  
value', mf_mapclasse4_valueMax= 'new value'  
mf_mapclasse5_valueMin = 'new  
value', mf_mapclasse5_valueMax= 'new value'  
WHERE visible_name= 'mapname'");  
  
mysql_close($con);  
  
  
//update text in map legend  
  
$con = mysql_connect("localhost","root","****");  
if (!$con)  
{  
die('Could not connect: ' . mysql_error());  
}  
  
mysql_select_db("natatlas", $con);  
  
mysql_query("UPDATE naexpertsript SET mk_keyclaas1_value = 'new  
value', mk_keyclaas2_value = 'new value', mk_keyclaas3_value = 'new  
value';mk_keyclaas4_value = 'new value',  
mk_keyclaas5_value = 'new value';  
WHERE visible_name= 'mapname'");  
  
mysql_close($con);
```



```
// map design is not changed; only "lastcheck will be updated.
$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

mysql_query("UPDATE naexpertsript SET lastcheck='new value';
WHERE visible_name= 'mapname'");

mysql_close($con);
?>
```

Appendix C

Scenario 3

C.1. Check datasets on CBS server and on atlas server

```
<?php
$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

$result = mysql_query("SELECT mean_p_15_ FROM provincie_tmp");

$min1 = 100000000;
$max1 = -100000000;

while($row = mysql_fetch_array($result))
{
//echo $row['mean_p_15_'];
$ft = $row['mean_p_15_'];
if ($max1 < $ft)
$max1 = $ft;
if ($min1 > $ft)
$min1 = $ft;
}

mysql_close($con);

echo "Maximum value CBS table". "-" . $max1;
echo "<br>";
echo "Minimum value CBS table". "-" . $min1;
echo "<br>";
$range1 = $max1 - $min1;
echo "Data range CBS table". "-" . $range1;
echo "<br>";

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("test", $con);

$result = mysql_query("SELECT * FROM province where ID= '5'");

$min1 = 100000000;
$max1 = -100000000;
```

```
while($row = mysql_fetch_array($result))

{
$groningen = $row['Groningen'];
$friesland = $row['Friesland'];
$drenthe = $row['Drenthe'];
$overijssel = $row['Overijssel'];
$flevoland = $row['Flevoland'];
$ gelderland= $row['Gelderland'];
$ utrecht = $row['Utrecht'];
$noordholland = $row['Noord-Holland'];
$zuidholland = $row['Zuid-Holland'];
$zeeland = $row['Zeeland'];
$noordbrabant = $row['Noord-Brabant'];
$ limburg = $row['Limburg'];
}

mysql_close($con);
$province =
array($groningen,$friesland,$drenthe,$overijssel,$flevoland,$gelderland,
$ utrecht,$noordholland,$zuidholland,$zeeland,$noordbrabant,$limbu
rg);
foreach ($province as $value)
{
//echo $value . "<br />";

$max2 = max($province);
$min2 = min($province);
}

echo "Maximum value atlas bureau table". "-" . $max2;
echo "<br>";
echo "Minimum value atlas bureau table". "-" . $min2;
echo "<br>";
$range2 = $max2 - $min2;
echo "Data range atlas bureau table". "-" . $range2;
echo "<br>";

if ($rangel1 != $range2) {
    echo "New classification method is required";
echo "<br>";
    echo "A message should be sent to the National Atlas bureau and
ask to chose an appropriate classification method";
    } else {
    echo "The same classification method is used";
    }

?>
```

C.2. Update class boudaries and text in map legend

```
<?php
// update class boundaries

$con = mysql_connect("localhost","root","****");
if (!$con)
```

```
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

$result = mysql_query("UPDATE naexpertsript SET
mf_mapClasses_mapclass1_valueMin = '7',
mf_mapClasses_mapclass1_valueMax=
'9',mf_mapClasses_mapclass2_valueMin =
'9',mf_mapClasses_mapclass2_valueMax=
'11',mf_mapClasses_mapclass3_valueMin =
'11',mf_mapClasses_mapclass3_valueMax=
'13',mf_mapClasses_mapclass4_valueMin =
'13',mf_mapClasses_mapclass4_valueMax=
'15',mf_mapClasses_mapclass5_valueMin =
'15',mf_mapClasses_mapclass5_valueMax= '21'
WHERE es_name= 'pctLeeft15_24prov'");

//while($row = mysql_fetch_array($result))
{
mysql_close($con);
//echo $row['mf_mapclass1_valueMin'];
echo $result;
}

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

$result = mysql_query("SELECT * FROM naexpertsript WHERE
id='143'");

while($row = mysql_fetch_array($result))
{

$mfmapClassesmapClass1valueMin =
$row['mf_mapClasses_mapClass1_valueMin'];
$mfmapClassesmapClass1valueMax =
$row['mf_mapClasses_mapClass1_valueMax'];
$mfmapClassesmapC2ass1valueMin =
$row['mf_mapClasses_mapClass2_valueMin'];
$mfmapClassesmapC2ass1valueMax =
$row['mf_mapClasses_mapClass2_valueMax'];
$mfmapClassesmapC3ass1valueMin =
$row['mf_mapClasses_mapClass3_valueMin'];
$mfmapClassesmapC3ass1valueMax =
$row['mf_mapClasses_mapClass3_valueMax'];
$mfmapClassesmapC4ass1valueMin =
$row['mf_mapClasses_mapClass4_valueMin'];
$mfmapClassesmapC4ass1valueMax =
$row['mf_mapClasses_mapClass4_valueMax'];
```

```
$mfmapClassesmapC5ass1valueMin =
$row['mf_mapClasses_mapClass5_valueMin'];
$mfmapClassesmapC5ass1valueMax =
$row['mf_mapClasses_mapClass5_valueMax'];

mysql_close($con);
$boundary = array($mfmapClassesmapClass1valueMin
, $mfmapClassesmapClass1valueMax, $mfmapClassesmapC2ass1valueMin, $mfma
pClassesmapC2ass1valueMax, $mfmapClassesmapC3ass1valueMin, $mfmapClass
esmapC3ass1valueMax, $mfmapClassesmapC4ass1valueMin, $mfmapClassesmapC
4ass1valueMax, $mfmapClassesmapC5ass1valueMin, $mfmapClassesmapC5ass1v
alueMax);
foreach ($boundary as $value)

echo $value. "<br />";
}
?>

// update text in a map legend

<?php

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

$result = mysql_query("UPDATE naexpertsript SET mk_keyClass1_value
= '7-9', mk_keyClass2_value = '9-11', mk_keyClass3_value = '11-
13',mk_keyClass4_value = '13-15',mk_keyClass5_value = '15-21'
WHERE es_name= 'pctLeeft15_24prov'");

//while($row = mysql_fetch_array($result))
{
mysql_close($con);
//echo $row['mf_mapclass1_valueMin'];
echo $result;
}

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

$result = mysql_query("SELECT * FROM naexpertsript WHERE
id='143'");

while($row = mysql_fetch_array($result))
{
```

```
$mkkeyClass1value = $row['mk_keyClass1_value'];
$mkkeyClass2value = $row['mk_keyClass2_value'];
$mkkeyClass3value = $row['mk_keyClass3_value'];
$mkkeyClass4value = $row['mk_keyClass4_value'];
$mkkeyClass5value = $row['mk_keyClass5_value'];

mysql_close($con);
$boundary =
array($mkkeyClass1value,$mkkeyClass2value,$mkkeyClass3value,$mkkeyCl
ass4value,$mkkeyClass5value);
foreach ($boundary as $value)

echo $value. "<br />";
}

?>
```

C.3. Update atlas data metadata

```
//update fields:"lastchange" and "lastcheck"

<?php

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

$result = mysql_query("UPDATE naexpertsript SET lastchange='2010-
01-01 00:00:00',lastcheck='2010-01-01 00:00:00'
WHERE es_name= 'pctLeeft15_24prov'");

//while($row = mysql_fetch_array($result))
{
mysql_close($con);
//echo $row['mf_mapclasse1_valueMin'];
echo $result;
}

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

$result = mysql_query("SELECT * FROM naexpertsript WHERE
id='143'");

while($row = mysql_fetch_array($result))
```

```
{  
  
$lastchange = $row['lastchange'];  
$lastcheck = $row['lastcheck'];  
  
mysql_close($con);  
$boundary = array($lastchange,$lastcheck);  
foreach ($boundary as $value)  
  
echo "Last change of map design template";  
echo "<br>";  
echo $value. "<br />";  
  
echo "Last check of map design template";  
echo "<br>";  
echo $value. "<br />";  
  
}  
  
?>
```

Appendix D

Scenario 4

D.1. Check and detect changes of datasets on CBS server and on atlas server

```
<?
$USERNAME = 'natatlas'; //database username
$PASSWORD = '****'; //database password
$DATABASE = 'natatlas'; //database name
$URL = 'pubnl03.itc.nl'; //database location

if(isset($_GET['getprovince(CBS)']))
{
pgsql_connect($URL, $USERNAME, $PASSWORD);
pgsql_select_db($DATABASE) or die('Cannot connect to database.');
```

\$returnArray1 = array();

```
$query = 'SELECT prov_naam,datasetname FROM province(CBS)';
$result = pgsql_query($query);

while($row = pgsql_fetch_assoc($result))
{
array_push($returnArray, $row);
}

pgsql_close();
echo json_encode($returnArray);

// extract statistical dataset from atlas server

if(isset($_GET['getprovince']))
{
$db_name= natatlas
    $connection=mysql_connect("localhost", "root", "****")
    $selection=mysql_select_db($DATABASE) or die('Cannot
connect to database.');
```

\$returnArray2 = array();

```
    $query="SELECT* FROM province WHERE es_name LIKE
'$datasetname
    $result = mysql_query($query);

while($row = mysql_fetch_assoc($result))

{
array_push($returnArray, $row);
}

mysql_close();
echo json_encode($returnArray);
```



```
// compare two array
if ('array1')!= ('array2')
    print 'Geography and attribute information are changed !'
    'Send message to National Atlas bureau to change an
    existing geography(a province is split)!'{
} else {
    print 'Geography and attribute information are not changed !'
}
?>
```

D.2. Add new field and update fields

```
// insert new filed in mysql table
<?
$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("test", $con);

mysql_query("INSERT INTO province (the name of province)
VALUES ('value')");

mysql_close($con);
?>

// update table "naexpertsript"

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

mysql_query("UPDATE naexpertsript SET mf_mapclasse1_valueMax= 'new
value',
mf_mapclasse2_valueMin = 'new
value', mf_mapclasse2_valueMax= 'new value'
mf_mapclasse3_valueMin = 'new
value', mf_mapclasse3_valueMax= 'new value'
mf_mapclasse4_valueMin = 'new
value', mf_mapclasse4_valueMax= 'new value'");
?>
```

```

                                mf_mapclasse5_valueMin = 'new
value', mf_mapclasse5_valueMax= 'new value'
WHERE visible_name= 'mapname');

mysql_close($con);

//update text in a map legend

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

mysql_query("UPDATE naexpertsript SET mk_keyclaas1_value = 'new
value', mk_keyclaas2_value = 'new value', mk_keyclaas3_value = 'new
value';mk_keyclaas4_value = 'new value',
mk_keyclaas5_value = 'new value';
WHERE visible_name= 'mapname');

mysql_close($con);

// map design is changed

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

mysql_query("UPDATE naexpertsript SET lastchange='new
value',lastcheck='new value';
WHERE visible_name= 'mapname');

mysql_close($con);

?>
```

Appendix E

Scenario 5

E.1. Check and detect changes of datasets on CBS server and on atlas server

```
// extract statistical dataset from CBS server

<?
$USERNAME = 'natatlas'; //database username
$PASSWORD = '****'; //database password
$DATABASE = 'natatlas'; //database name
$URL = 'pubnl03.itc.nl'; //database location

if(isset($_GET['getprovince(CBS)']))
{
pgsql_connect($URL, $USERNAME, $PASSWORD);
pgsql_select_db($DATABASE) or die('Cannot connect to database.');
```

\$returnArray1 = array();

\$query = 'SELECT datasetname FROM province(CBS)';
\$result = pgsql_query(\$query);

while(\$row = pgsql_fetch_assoc(\$result))
{
array_push(\$returnArray, \$row);
}

pgsql_close();
echo json_encode(\$returnArray);


```
// extract statistical dataset from atlas server

if(isset($_GET['getprovince']))
{
$db_name= natatlas
    $connection=mysql_connect("localhost", "root", "****")
    $selection=mysql_select_db($DATABASE) or die('Cannot
connect to database.');
```

\$returnArray2 = array();

\$query="SELECT* FROM province WHERE es_name LIKE
'\$datasetname
\$result = mysql_query(\$query);

while(\$row = mysql_fetch_assoc(\$result))
{
array_push(\$returnArray, \$row);
}

```
mysql_close();
echo json_encode($returnArray);

// compare two arrays
if ('array1')!= = ('array2')
    print 'Size of symbols are changed!'{
} else {
    print 'Size of symbols are not changed!'
}
?>
```

E.2. Update class boundaries and text in map legend

```
// update table "naexpertsript"

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

mysql_query("UPDATE naexpertsript SET mf_mapclasse1_valueMax= 'new
value',
mf_mapclasse2_valueMin = 'new
value', mf_mapclasse2_valueMax= 'new value'
mf_mapclasse3_valueMin = 'new
value', mf_mapclasse3_valueMax= 'new value'
mf_mapclasse4_valueMin = 'new
value', mf_mapclasse4_valueMax= 'new value'
mf_mapclasse5_valueMin = 'new
value', mf_mapclasse5_valueMax= 'new value'
WHERE visible_name= 'mapname'");

mysql_close($con);

//update text in map legend

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}
```

```
mysql_select_db("natatlas", $con);

mysql_query("UPDATE naexpertsript SET mk_keyclaas1_value = 'new
value', mk_keyclaas2_value = 'new value', mk_keyclaas3_value = 'new
        value';mk_keyclaas4_value = 'new value',
mk_keyclaas5_value = 'new value';
WHERE visible_name= 'mapname'");

mysql_close($con);

// map design is not changed; only "lastcheck will be updated.

$con = mysql_connect("localhost","root","****");
if (!$con)
{
die('Could not connect: ' . mysql_error());
}

mysql_select_db("natatlas", $con);

mysql_query("UPDATE naexpertsript SET lastcheck='new value';
WHERE visible_name= 'mapname'");

mysql_close($con);

?>
```