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NSDI Good Practices – The Netherlands

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List of Abbreviations

IMRO	Information Model for Spatial Planning
NCGI	NSDI Clearing House
NORA	Dutch Government Reference Architecture
PDOK	Maps for Services
RAVI	Dutch Council for Real Estate Information
RGI	Space for Geoinformation Program
TNO	Geological Survey
VROM	Ministry of Spatial Planning and Environment[1]

[1] Later Ministry of Environment and Infrastructure

1. Executive Summary

The NSDI in the Netherlands was built in a combined bottom up and top down approach within nearly 15 years. The vision for geoinformation was adopted by the Parliament in 2009 and the starting question of "what is the policy of the nation - what do we want to achieve" has led to a fully functional NSDI nowadays.

At the organizational level, the Ministry of Environment and Infrastructure[2] has overall responsibility for the NSDI. On its side, Geonovum, the GI-Council, the Space for Geoinformation program and GIDEON played a catalytic role in realizing the NSDI. The Dutch NSDI is harmonized with the INSPIRE directive and the national open data policy.

The NSDI is based on the concept of Key-registers which is the authoritative and legally defined national datasets. The reuse of the data within the government is obligatory and ensures high quality and reliability.

In the pre-NSDI period, connections and geodata exchanges between different organizations had already been established. In building the NSDI, these two to three way relations were redirected to a central node from which all the data and metadata are now accessed.

The interface of the central node is the PDOK portal connecting users to data providers. The National Georegister is the central metadata portal for searching and retrieving (INSPIRE) geoinformation and it is integrated in the PDOK portal. The responsibility of the data quality and maintenance remains at the providers' side.

Technologically, mostly open source software is used such as Geoserver, Geo webcache, Postgress, QGIS, or developed such as Arcgis, Qgis extension for PDOK. OGC services and standards as well as ISO standards and INSPIRE compliant geostandards are adopted.

The report is organized as follows. In section 2 some information about the country is provided. Section 3 and 4 are dedicated to the pre-NSDI landscape in the Netherlands and the activities undertaken to establish the NSDI. In section 5 and 6, an overview of the Dutch NSDI today is given and in section 7 the maturity level assessment is provided.

[2]Former Ministry of Spatial Planning and Environment (VROM)

2. An Introduction to the Country

Basic Data			
Area	41,55 km2	**Total GDP (PPP)**	834.705 billion euros
Water	18.41 km2	**Per Capita GDP (PPP)**	48.871 euros
Capital	Amsterdam	**Human development Index**	0.924
Population	17.100.475	**Currency**	euro
Population Density:	412.3 persons /km2	**Official languages**	Dutch, Frisian, English, Papiamento

Netherlands lies between latitudes 50° and 54° N, and longitudes 3° and 8° E. It is a flat country; 26% of the area is below sea level and 50% is about a meter above sea level. It has a maritime climate dominated by humidity. Three islands in the Lesser Antilles are part of the Caribbean Netherlands.

As regards its political structure, Netherlands has been since 1815 a constitutional monarchy and since 1848 a parliamentary democracy. The King is the head of the State. The head of government is the Prime Minister of the Netherlands. Netherland is ranked 10th as the most democratic country worldwide (economist report).

Netherlands is divided into 12 provinces that are further subdivided into 388 municipalities, and 22 water districts.

From an economic aspect, Netherlands has a high level of economic freedom (17th in 2014), it was third in the Global Enabling Trend Report in 2004. It is one of the major European countries attracting foreign investments.

The geoinformation sector is very strong with companies such as Tomtom, ESRI Netherlands, Teleatlas based in the Netherlands. According to recent studies (Narain, 2017), the country ranks third concerning the geoinformation readiness level following the United States and the United Kingdom. It is one of the pioneers in introducing Cloud-Based web portals for real time satellite data access. Open source and open access are highly used and promoted within the public sector

3. The pre-NSDI landscape

3.1 First steps towards an SDI

National spatial planning in the Netherlands had already started in 1941 with the establishment of the Bureau for the National Plan inside the Ministry of the Interior. In 1965, this evolved into a National Department for Spatial Planning inside the Ministry of Housing and Spatial Planning. Additionally, an interministerial committee and an advisory group for spatial planning were formed. During these early stages of the development of the national spatial planning, specific policies were created, which are shown below:

The private sector has been active from the very beginning in developing geoinformation products and services.

- Tele Atlas was founded in 1984 focusing on digital maps for navigation and location based services.
- Since 1985 GEODAN existed. It is an independent private sector organization that is run by 80 employees. GEODAN's targeted market is Government, Semi-government and Businesses such as Retail, Telco's, Energy companies, Media. The integration of OpenGIS systems is the main task of GEODAN.
- TomTom founded in 1991, started with B2B mobile applications and personal digital assistants (PDAs) and gradually leaded the PDA software with navigation applications market.

3.1.1 Initiation Phase

The time from 1990 to 1998 can be considered as the Initiation Phase of the Dutch SDI era (Bregt and Meerkerk, 2008). An official advisory committee on land information named RAVI (Dutch Council for Real Estate Information) was established with a consultative role on spatial information for the Ministry of Spatial Planning and Environment (VROM). At the same time, the concept of Key-registers as an authoritative way of organizing and sharing both spatial and non spatial datasets was introduced (Bakker, 2011).

In 1992, RAVI became independent from VROM. It had representatives from the public sector and its main role was to promote the necessity of sharing geoinformation within the public sector. It also proposed an implementation plan for authorities to make agreements with

each other and to start exchanging their geodatasets (Bregt and Meerkerk, 2008). RAVI was in charge of coordinating the whole geoinformation sector (Van der Molen and Wubbe, 2007).

In 1995, the Dutch NSDI clearing house (NCGI) "National Clearinghouse Geoinformation Netherlands" was formed as an initiative of RAVI and the Ministry of Housing and Spatial Planning and Environment, signifying the transition from geographical information systems to Geoportals services (from geodatasets to geoservices) (Fig. 1). Its mission was to provide geoinformation and application services via the Internet. With the increasing use of mobile connections, these services began also to be provided to the users any time at any place. The service architecture is depicted in Fig. 2.

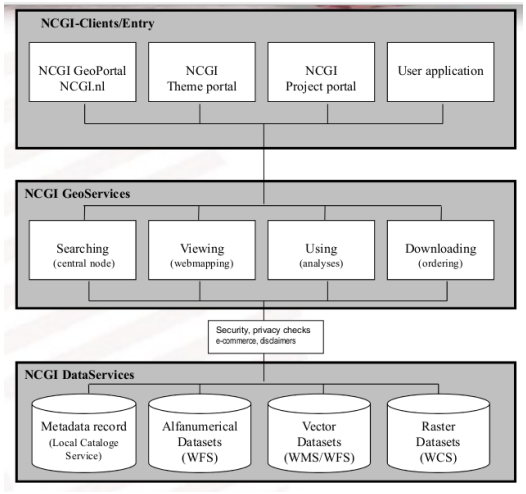


Figure 1: Service architecture of NCGI (source: Peter van de Crommert, 2002)

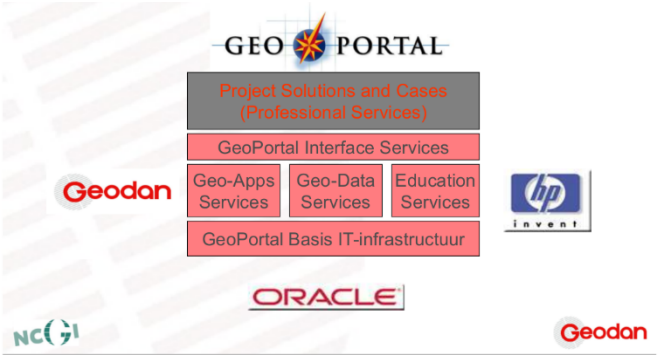


Figure 2: Geoportal services in NCGI (source: Peter van de Crommert, 2002)

For the standards, the W3C, OGC Web Services (OWS), Metadata Standards (CEN/ISO), J2EE, Oracle 9iDB, Oracle 9iAS, Oracle 9i Spatial Option were used. The benefit of the portal approach was that data was not kept locally but shared on the web and Geo Processing Resources (services) could be approached from a distance. Already since then, the problem of connecting the portals and the need for the use of open standards was identified. NCGI received four years of government funding. Additional funds were project based and came from the portal owners. In 1996, it became an online resource.

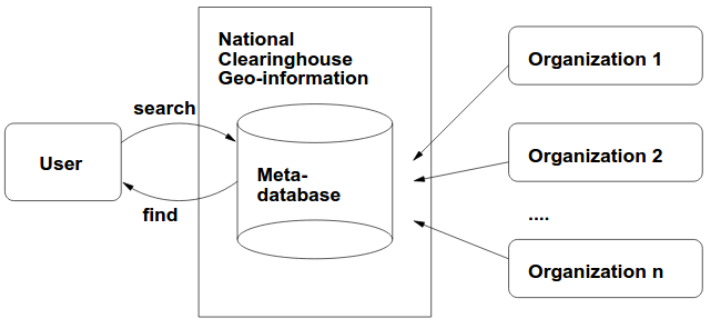


Figure 3: Metadatabase inclusion in the NCGI architecture (source: De Gunst and Van Oosterom, 1997)

At the same time (1996), GEODAN developed Idefix, which was the first national GI metadatabase to enable countrywide sharing of the geodatabases. This project was funded by the Ministry of Economic Affairs and was based on MS-Access. The infrastructure was further

developed by NCGI in 1997. Netherlands Normalization Institute (NEN) provided also GI related standards. Metadatabases, search and query functionalities were central issues in the NCGI infrastructure. How these are related is depicted in (Fig. 3). From 2001-2004, the clearinghouse is being managed and exploited by GEODAN taking care of the further development of the metadata services.

3.1.2 Awareness Phase

The period between 1998 – 2003, was the second phase or so called "Awareness phase" (Bregt and Meerkerk, 2008) characterized mainly by problem identification and awareness creation (especially political) with a view to setting the agenda for the new era of the NSDI. The already established geodata exchange of the authorities was assessed via the SWOT method, according to which, the strengths, weaknesses, opportunities and drawbacks of the Dutch SDI around 2001/2002 were investigated and documented. Results are demonstrated in Table 1. Although this method gives only qualitative results, without certain indicators and numbers, it provided a good overview of the SDI and was used for further development.

Table 1: Results of SWOT analysis (source Bregt et al, 2008)

Strengths	Weaknesses
• Internationally perceived, The Netherlands is a geodata-rich country and is potentially equipped to convert this into geo-information wealth • It has commanded a strong position in the field of geo-information from time immemorial • Strong networks of parties who work collaboratively and exchange knowledge on geo-information, joined together in various interdisciplinary organisations with RAVI as umbrella organisation • The hallmark of the sector is its soundness • Extensive and sturdily growing geowork field • Presence of abundant knowledge and experience in the field of satellite observations	• The geoinformation facility set up is sectoral and has no coherent concept. Problems lie with: exchange, duplication of data collection, integration of files and data, standardisation and accessibility • Dissemination of geo-data is very supply oriented and many organisations are extremely reticent about making data available • There is little awareness of the concept of the NCGI and it has been insufficiently promoted • The sector is introvert and the exchange of information does not function well
Opportunities	**Drawbacks**
• Space in The Netherlands is scarce; there is need of multifunctional and high-quality use of space. There is an Increasing need of integration and linking of geoinformation to support spatial decisions. • The growing need of open and transparent policy-making demands the direct accessibility of geoinformation	• Integral solutions for social problems with the help of geoinformation hardly gets off the ground • Inability to take advantage of international social issues and international legislation • Education and research are lagging behind because the sector is not appealing enough

• New ICT developments offers the geoindustry new opportunities and brings technologies to consumers (e.g. GPS) and mobile • The ambition of the Dutch cabinet to make information available for innovative purposes • It is the ambition of The Netherlands to be among the leaders of Europe in the field of knowledge and information economy • The ad-hoc demand for geoinformation creates a new structural demand • The digital era has altered map use into dynamic models and has paved the way for new applications such as virtual reality	• Companies lack sufficient innovative power • Risk of large disinvestments in the infrastructure components because of the lack of a coherent NGII concept • The old coordination-oriented approach is no longer enough; powerful steering is needed

In 2000, the NCGI version 1.1 was published offering:

- a central search engine where all data providers made their data available through the internet
- a central list of participants
- redirections from the central server to the institute's servers where the data is stored

The architecture is shown in Fig. 4.

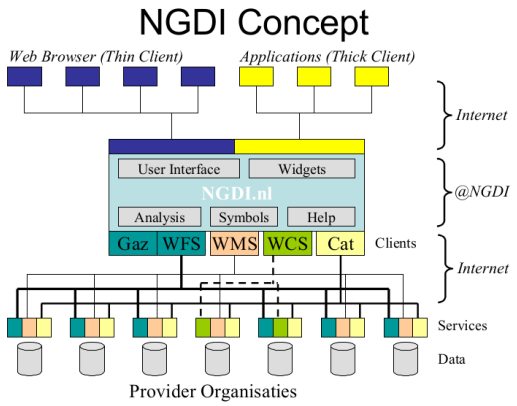


Figure 4: Architecture of the NCGI 1.1 version (source: Peter van de Crommert, 2002)

In the status report (2001), already 13 data suppliers with 1500 dataset had joined NCGI and many technical and organizational problems had been identified. From 1997 to 2000, 1.5 million euros was invested in the project (excluding metadata and conversion costs).

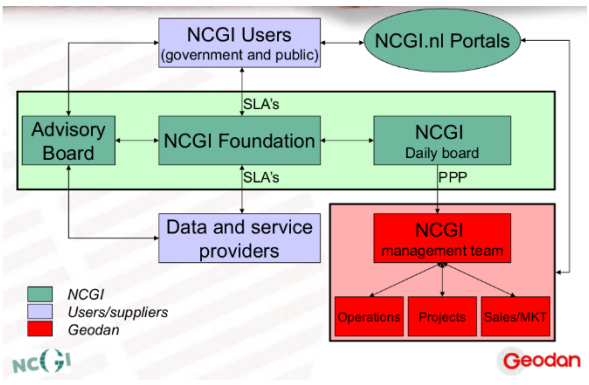


Figure 5: Organizational structure of NCGI (source: Peter van de Crommert, 2002)

In 2001, an agreement was made concerning the cooperation between the NCGI Foundation and GEODAN under the following arrangements; NCGI remains owner of the infrastructure and GEODAN is responsible for the exploitation and the maintenance. The organizational structure of NCGI is shown in Fig. 5.

3.2 Legislation

In the pre-NSDI period, legal aspects of the geoinformation sector were covered by:

- Government Information Public Access Act (1991): Documents created by public agencies should be made available for everyone. The price is based on dissemination costs. Copyrights and database rights can be claimed by Government agencies.
- Act containing regulations governing public access to government information (1991).
- Freedom of Information and reuse of public sector information.
- European Directive on Privacy Protection (1995).
- ''Towards the Accessibility of Government information'' document (1997).
- European Directive for Legal Protection of Databases (1999).
- Personal Data Protection Act (2000).
- ''Constitutional rights in the digital era'' (2000) - change the role of the Government from ''controlling government'' to ''the public right to access government information''.

3.3 Geospatial information in the pre-NSDI landscape

3.3.1 Key-Registers

In 2000, the notion of Key-registers or base-registers was adopted to define high quality and reliable official datasets to be used throughout the public sector and, if possible, by the private sector, unless privacy issues would emerge (Van der Molen and Wubbe, 2007). Key-registers are the first and fundamental advancements of having legally and organizationally defined datasets in the Netherlands and are essential for implementing eGovernance (see section 3.5.5).

These Key-registers referred both to spatial and non-spatial data. At the beginning, 6 Key-registers existed. The Key-registers of building and addresses were developed from scratch while for the others, data already existed. Laws for registers of personal records, cadastre and geography were endorsed by the Parliament in 2007 and came into force in 2008.

Initial Key-registers
- register of personal records
• - trade register
• - cadastre
• - geographic information 1:10000
• - buildings
• - addresses

Key-registers added in 2007
- register of cars number plates
- register of wages
- labour relation and social allowances
- register of income
- register taxation value of real estate

From 2007, a reassessment of the registers and the proposal of new ones was made.

In order to provide the registers in a centralized manner, the National Access Services were introduced. Data was collected and maintained by the appropriate organization and it was then shared via the National Access Services. The Cadastre, Land Registry and Mapping Agency was responsible for the National Access Service of the register of buildings, addresses, cadastre, geography as well as for the large-scale topography maps. The various National Access Services were coordinated by the Government Wide Shared Service Organization.

As far as restricted land areas were concerned, for a long time it had been very difficult to obtain data. From 2007, the "WKPB: Disclosure of Impediments under Public Law in respect of Real Estate Act" came into force. Main goal of the act is to provide easy access to information of restrictions made by a governmental organisation to an area or a building.

The municipalities and the Cadastre, Land Registry and Mapping Agency were in charge of providing that data. Each municipality had to maintain their own register of restriction areas (leading to 450 municipal registers). The Cadastre was responsible for the remaining public restricted areas which were accessible through the Kadastrer-on-line service. The municipalities had to contribute the data to a national database which was accessible through the Kadastre-on-line service. As a result, a countrywide coverage of all restricted area was provided via a National Access Service.

3.3.2 Geoinformation Products

- From 1975 to 2000 the Large Scale Topographic Base Map (GBKN) was produced and converted to a digitised geo set.
- A digital elevation model of the whole country was produced by the Ministry of Transport, Public Works and Water in 2003. Access was provided via a geoportal.
- Top 10 – Vector data set at a scale of 1:10000 produced by the Topographic Service of the Netherlands.
- Land Cover database by the DLO-Staring centrum.
- Land Cover ecological database of the Netherlands made by the DLO-Staring centrum.
- Waterways geodataset made by the Survey Department of the Directorate General of Public Works and Water Management.
- Geology Geodatasets made by the National Geological Survey (NITG-TNO).
- Archaeology geosataset made by the Institute for Archaeological Soil Exploration.
- Cadastral map made by the Cadastre.
- By the end of 2007 all land use plans were digitized.

3.3.3 Geodetic Reference System

The national reference system is the Rijksdriehoeksstelsel (RD) with the Bessel ellipsoid of 1841 and an azimuth stereographic projection with ± 4000 higher order points. For GPS observations, ETRS is used.

3.3.4 Costs - Profits

The Large Scale Map of the Netherlands (GBKN) was financed by the Dutch municipalities, the Cadastre and the utility companies and telecom. It was continuously maintained and financed by the same partners. The production costs were 370 million euros.

By digitizing the Top 10-Vector data set 1:10000 and avoiding duplications, the government gained 21 million euros.

3.4 Space for Geoinformation Program (RGI)

By the end of 2003, many authorities had started making connections with each other and sharing some of their geodata. At that time, BSIK the governmental innovation program, was launched having a pivotal role on geographic information. The goal of BSIK was to strengthen the research and development activities in the Netherlands by funding academic and industrial cooperation. The total budget of BSIK was 800 million euros and was distributed to 37 projects.

One of the funded projects was the RGI (Ruimte voor Geo-Informatie - Space for Geoinformation) program (Bregt and Meerkerk, 2007) starting in 2004 until 2009. RGI had a budget of 20 million euros from BSIK. Acknowledging the importance of RGI, the geo-sector also invested 22 million euros for supporting the same goal -hence for this collaboration there was a total budget of 42 million euros (VROM, 2008).

The aim of RGI was '*the enhancement and innovation of the geo-information infrastructure and the geoknowledge community in the Netherlands towards sound and efficient public administration and a robust business*" (Bregt and Meerkerk, 2007).

The topics of the call for projects were:

- Geoinformation infrastructure concepts such as interoperability, OpenGIS/ISO architecture, standards, integration of geoinformation from multiple sources etc.
- Spatio temporal modelling such as multi-scale modelling, 3D modelling, semantic modelling, modelling uncertainty etc.
- Geographic man-machine interaction such as visual analysis and interactive use of geoinformation, 3D visualizations, Virtual/Augmented reality etc.
- Geoinformation and Society such as user needs, legal aspects, financing, cultural aspects etc.

The budget was allocated to 40 RGI-projects and 30 RGI-innovation pilots some of which were:

- Virtual Netherlands
- Framework for the review of NSDI's

- 3D Topography
- Fire brigade 100% digital
- GIS for risk prevention
- High water forecast based on satellite information
- How to start NSDI (Van der Molen and Wubbe 2007)
- The Potential of a National Atlas as Integral Part of the Spatial Data Infrastructure Exemplified by the New Dutch National Atlas (Kraak and Aditya, 2014).

As it can be seen in the list above, very diverse aspects of the geoinformation sector ranging from geo-information infrastructure concepts, spatio temporal modelling, geographic man machine interaction, safety and security to geoinformation and society were investigated (Bregt and Meerkerk, 2007).

RGI-projects lasted for maximum 4 years and had a budget from 250000 to 10 million euros while RGI-innovation pilots were smaller and had a maximum budget of 50000 euros.

The RGI program was run by an independent organization which was responsible for monitoring the projects as well as facilitating the networking of the partners. This organizational structure was formed by:

- the RGI board which was responsible for allocating the funding to each project and monitoring its progress
- the supervisory board consisting of high level governmental officials, the science advisory for selecting the projects and the knowledge engine (user advisory board).

RGI was characterised by a strict meeting and reporting policy i.e. the RGI board had to meet every two months and the supervisory board twice per year (Bregt and Meerkerk, 2007).

The outcomes of the RGI project were primarily the knowledge gained on the different themes but most importantly the networking aspects resulting in 250 organizations cooperating with each other. It was also the activator for discussions and think-tanks among domain experts and policy makers on the vision and next steps of establishing the NSDI (Bregt, 2008).

3.5 Partnerships – Collaborations

3.5.1 Cadastre – Notaries collaborations

Since 2005, the deeds have been submitted digitally. Based on these deeds the Cadastre offices updated manually the cadastral databases. Although a lot of effort had been put by the Cadastre with support from the academic community to automatize the process of updating the cadastral databases based on the deeds, the heterogeneity of the texts made the process impossible. In 2006, the Notaries and the Cadastre signed a agreement to

cooperate for standardizing the format of the deeds, so that information can be easily recognizable by systems. As a result, deeds were divided in two parts; the one being universal and including all the essential data to automatically update the cadastral database and the second being case specific (van Veller and Gerritsma, 2009).

3.5.2 Cable and Pipeline Information Centre (KLIC)

An important cooperation emerged due to the money loss (40-75 million euros yearly) of 40.000 cases, where cables and pipelines were damaged during construction works. This was due to the missing linkage of geoinformation between the construction companies and the data owners (telecom and utility owners). Sharing this data was guided also by legal bindings and resulted in a common agreement between the Minister of Economic Affairs and the Minister of Housing, Spatial Planning and Environment on sharing information about the subsurface cables and pipelines (Van der Molen and Wubbe, 2007). The Cadastre took over the responsibility of the Cable and Pipeline Information Centre (KLIC) to provide the data to the construction companies (Bakker, 2011). The process was confirmed legally by the introduction of a law regarding information exchange on all subsoil networks in 2008 (Koppens, 2014).

3.5.3 Large Scale Topographic Base Map (GBKN)

The production started in 1975 and was finished in 2000 with total costs of 230 million euros. The maintenance activities were shared between the national managing board and regional executive bodies. They were mainly PPP's of the Cadastre, municipalities, provinces, waterboards, telecom and utility companies, who financed all operations. The costs of transforming the GBKN to a key-register was estimated up to 19,5 million euros with an annual maintenance cost of 20 million euros (van der Molle and Wubben, 2007). In 2017, the GBKN will be completely transformed into the key register Large Scale Topography (BGT).

3.5.4 Dataland

Municipalities have been very active in collecting and maintaining geoinformation and were the only source for datasets such as addresses, use and value of buildings, floor space etc. However, they operated on a very autonomous way and the information was not available on regional and central level. Dataland was founded in 2001 as a non-profit cooperation of municipalities to harmonize their data and make it widely accessible.

3.5.5 Cooperation project in the Veluwe region

In 2006, the Cadastre, 4 Municipalities, Large Scale Topographic Base Map, Draft-Authentic Register of Addresses, and Dataland, collaborated in a project in the Veluwe region to underline the importance and usefulness of key-registers in spatial infrastructure. The project was very successful and was further used in the NSDI national policy (van der Molle and Wubben, 2007).

3.5.6 Cross-border collaborations

Around 2000, the Netherlands started cooperating with Northrein Westphalia (Germany). Three workshops (Duesseldorf 2001, Arnheim 2002 and Muenster 2003) intensified the networking of experts on all levels.

The Netherlands, Belgium and the state of NRW, cooperated in a cross boarder INSPIRE pilot to promote the need and advantages of geoinformation sharing, particularly in disaster management events.

Between NRW and the Netherlands a Cross-border SDI was prototyped. On the technical level, for providing the geoinformation OpenGIS compliant WMS, for metadata the WCS, and on the client side HTML-based multilingual Web Mapping Client and a multilingual portal were used. NCGI is responsible for the operating infrastructure from the Dutch side Fig.6.

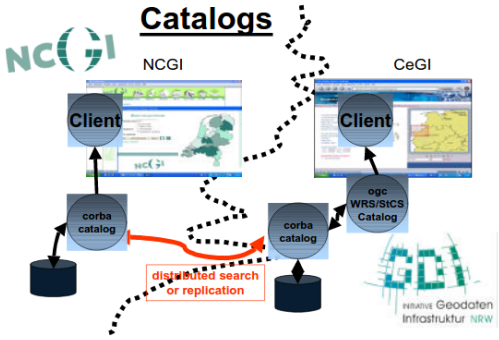


Figure 6: NRW - Dutch SDI collaboration (source: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.475.726&rep=rep1&type=pdf)

3.6 E-Government

The eGovernmnet policy has already been introduced in the Netherlands at the beginning of 1990. According to the Dutch Digital Delta program which is the implementation program of the ICT of eGovernment, *"A vibrant society with a healthy economy demands a strong government, which plays its role using the most advanced "tools" available. Only then can the government, faced with dwindling resources, continue to meet its performer and provider functions"*

3.6.1 On the history of the eGovernment strategy

- 1992: Structure online for Geoinformation, defined information of parcels of land, people, companies, buildings and addresses as the fundamental geoinformation layers.
- 1994: National Action Program on Electronic Highways.
- 1998: First Electronic Government Action Plan for using ICT in government services was launched and followed by the Memorandum "Contact with the Future". With these two the Dutch electronic government (ELO) begun.
- 1999: Publication of "Digitale Delta – Nederland Online", a policy for e-economy in the Netherlands with special focus on the use of ICT in the public sector.
- 2000:
    - Publication of the policy document "Contract with the future: A vision on the electronic relationship between government and citizens".

    - Introduction of the Electronic Public Desk.
    - Publication of the Memorandum “Towards Optimum Availability of Public Sector Information” by the Ministry of Interior Affairs.
- 2001: Establishment of the ICT Unit (ICTU) by the Ministry of Internal Affairs and Kingdom Relations for coordinating the development of e-Government.
- 2002: Launching of the program “Better Services for Citizen and Business” by the Ministries of Interior, Economic Affairs and Justice.
- 2003: Introduction of the new action programme for implementing eGovernment namely “Another Government (Andere Overheid)”.

3.6.2 Organization of eGovernance

In the Netherlands, there is no Chief Information Officer or Minister politically responsible for the ICT policy. The Ministry of Economic Affairs coordinates the strategy and reports to the Cabinet. Each ministry, province and municipality is free to use their own systems but when it comes to inter-departmental programmes, the Dutch Organization for ICT and Government has the responsibility.

3.6.3 Access of information over the web

In 1999, a general governmental website was launched www.overheid.nl as the central access point to the government services. Its main goal was to ease the communication between citizens and the government and reduce bureaucracy. The high ICT literacy is confirmed by the fact that by 2001, all ministries, provinces and 70% of the municipalities had websites.

For strengthening the ICT capacity of local municipalities, the eCommunes (e-Gemeenten) project was launched in 2003 as a cooperation between the Central Government and the Dutch Communes for fostering cooperation, exchange of good practices, establishment common standards and projects between municipalities.

3.6.4 e-Services

The Public Key Infrastructure (PKI) was introduced as the assurance of safety of electronic communication between governmental authorities, businesses and institutions. Three functionalities are used within PKI: identification (DigiD), electronic signature and encryption.

In 2007, a 24 hours’ service for question assistance was provided by the Cadastre. An electronic contact form was also available. MijnKadaster, the Kadaster-on-Line was developed at the same time, providing access to all Cadastral services with the use of sinle ID (van der Molle and Wubben, 2007).

3.6.5 Authentic Registers (later Key-Registers)

In order to implement the eGovernment vision, there is a need for high quality official datasets. Each Ministry is responsible for a certain authentic register and has to continuously maintain and provide the data. The basic characteristics of the authentic dataseta are: high quality of information, high accuracy and currency, multiple use, liability, clear financing mechanisms, responsibility assigned to Ministry.

3.6.6 NORA: Dutch Government Reference Architecture

In order to implement the eGovernment strategy, organizations need support both on the technical and architectural level. NORA provides the essential support to organizations on the principles of how to collaborate, how to link processes and how to exchange data. In 2007, the Director for Innovation, Information and Organisation of the Ministry of Home Affairs and Kingdom Relationships documented the administrative framework of eGovernment. This was analysed further by NORA. Implementation principles have been documented for each component. In NORA 3.0 geoinformation is an integral part of the architecture framework.

3.6.7 DURP project

The DURP project – Digitally exchangeable spatial plans started in 2000 as a cooperation between the Ministry of Spatial Planning and professional organizations. The goal was to have by 2005 70% of all spatial plans in digital format in accordance with the General Geospatial Information Model NEN3610. It stimulated local municipalities, regional provinces and national authorities to produce digital maps. For the implementation, a model for standardised plan map, user instruction manuals and converters (from AutoCad, ArcGIS to IMRO standards (national standards for spatial plans)) were provided. The project was funded by the Ministry of Housing, Spatial Planning and the Environment, the Netherlands Institute of Housing and Planning, the Association of Dutch Municipalities, the Organization of Interprovincial Conversation and the Association of Dutch Urban Designers.

3.6.8 SDI for disaster management

In 2006, the GI Council initiated the development of an SDI for disaster management. It was realized as an interdepartmental partnership and was managed by the Ministry of Agriculture, Nature and Food Quality (LNV). This project was particularly important as it was a great indicator of the relation between supply and demand and the connection between suppliers and users.

4. Developing the NSDI

The Dutch NSDI, was developed at a time when already considerable progress had been made concerning the importance and value of geoinformation. This was strengthened by a study made in 2010 to define the economic value of the geoinformation sector (Castelein and Pluijmers, 2010). According to the study the value in 2008 was 1.4 billion euros and more than 15000 full time employees were active in the sector. The GDP of the Netherlands was 596 billion and the geoinformation sector was contributing 0.23% to the GDP of the country.

Nevertheless, geodata was not easy to access or was very expensive not to mention the complicated conditions of use and interoperability problems (Grus and Castelein, 2009). In 2006, a spatial data infrastructure for crisis management and disaster response was created by the GI-Council, demonstrating the political and administrative need for a NSDI.

The NSDI was developed in a combined bottom up and top down approach with several projects running at the same time in a complementary manner. The most important projects were:

- GIDEON – the key geoinformation facility for the Netherlands
- The Key Registers
- PDOK
- The national implementation of the INSPIRE Directive.

4.1 Organizational

4.1.1 Geonovum

Geonovum is a foundation formed in 2007 by authorities from the public sector under the supervision of the Ministry of Infrastructure and Environment (former Ministry of Housing, Spatial Planning and Environment). It was co-funded by the Ministry of Infrastructure and Environment, the Cadastre, the Ministry of Economic Affairs, Agriculture and Innovation and the Geological Survey (TNO) (Vanderbroucke and Biliouris, 2011). RGI and Geonovum took over the roles of RAVI and NCGI (see section 3). The main objectives of Geonovum are:

- To make geoinformation accessible in the Netherlands by developing and maintaining the required geostandards
- To act as a facilitator for the Dutch NSDI

Geonovum was coordinating the implementation of GIDEON as an executive committee and a coordinating body as well as implementing the operational coordination of INSPIRE. Its key tasks were (Vanderbroucke and Biliouris, 2011):

- *to develop and standardise the geo-information infrastructure while also being innovative*
- *to build up and disseminate knowledge in geo-information infrastructure*

- *to make the geo-information infrastructure more accessible to administrative bodies, institutions and departments in the Netherlands and the European Union.*

4.1.2 GI-Council

The GI-Council (or GI-Board) was established in 2006. It incorporated representatives from all governmental organizations and agencies related to the geoinformation sector such as ministries, municipalities, water authorities etc., (Vanderbroucke and Biliouris, 2011). It had an advisory role to the Ministry of VROM, similar to the National Council for eGovernment Services which had an advisory role to the Ministry of Interior (Grus and Bregt, 2011). Within the context of GIDEON, the GI-Council had the role of a steering committee that organized its implementation and monitored its progress (Castelein and Manso Callejo, 2010).

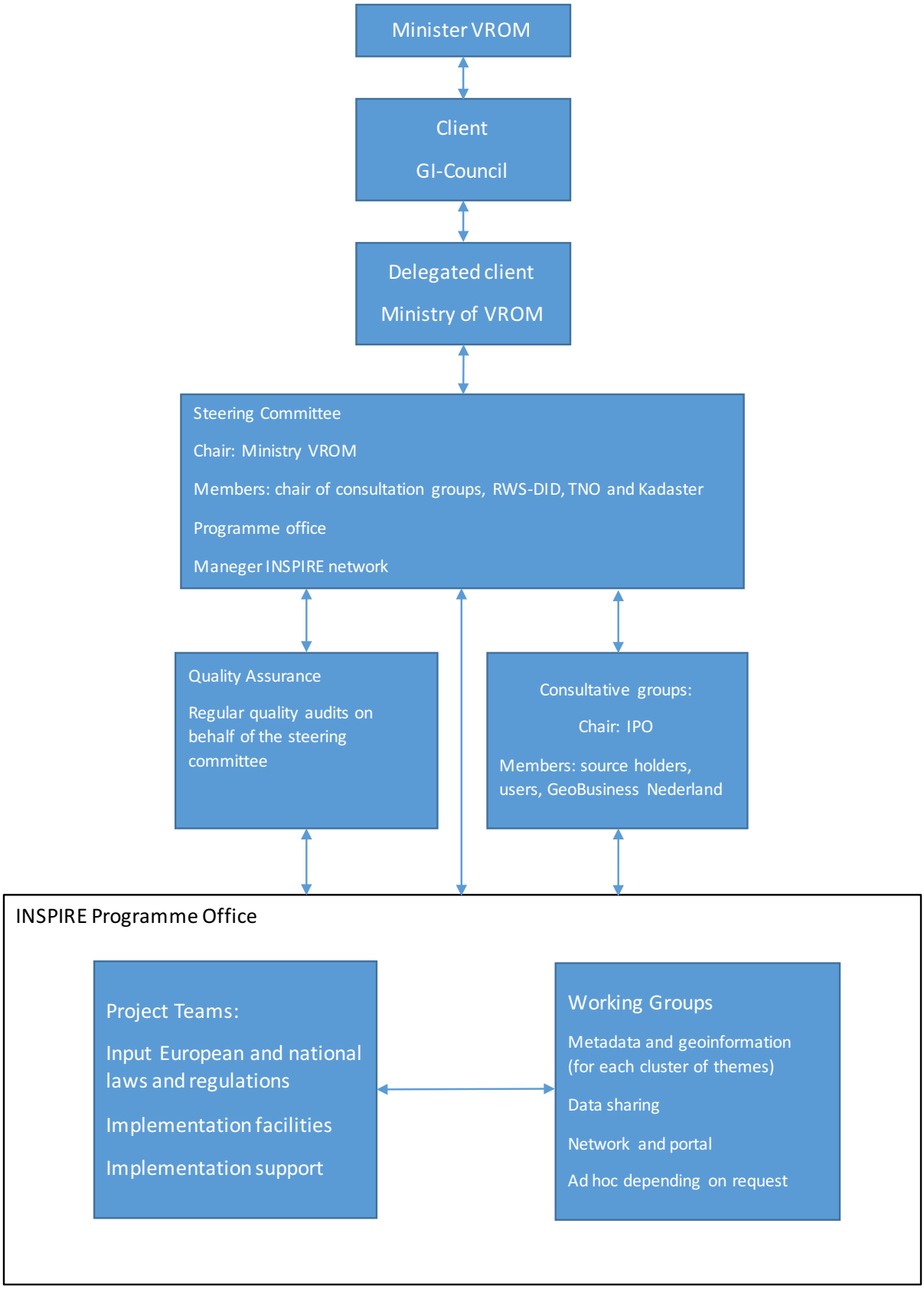
One very important activity undertaken by the GI-Council was the assessment of the quality of the already existing collaborations. Although the results of the assessment did not really provide numbers and indicators, they unveiled the potential for new cooperation and contributed in realizing the paradigm shift from thinking as an independent organization to thinking as part of a chain (De Bree, 2008).

4.1.3 Main organization providing geodata

- Topographic Service in the Netherlands: topographic maps 1:10000, 1:50000, 1:100000, 1:250000 and 1:1000000.
- Dutch Cadastre: cadastral dataset.
- Survey Department of the Ministry of Traffic and Water Control: road databases and height information.
- National Co-operative Foundation for Large Scale Base Map of the Netherlands (LSV-GBKN) which cooperated with the Cadastre, the Society of Municipalities, Utility Company Organizations and Union of Water and Control boards: large scale topographic map.
- Alterra: agricultural, forestry and soil geodata.
- Geoserve: remote sensing data.

The organizational structure is depicted below (source: INSPIRE Report, 2010)

Organizational Structure of the Dutch NSDI (source: INSPIRE Report, 2010)



4.2 Legal Aspects

The Ministry of VROM is the overall responsible body for the NSDI in the Netherlands. Key-registers are the backbones of the NSDI. They are the core authenticated dataset that governmental organizations are obliged to use. Their collection and maintenance is regulated by laws and followed by strict quality assurance policies.

- 2008:
  - The top 10NL (small scale topography (1:10000)) dataset of the Cadastre was defined by law as the official Key-register for topography.
  - The official register for addresses and buildings was set by law. From 2009 when the law came into force, local authorities were obliged to contribute their address and buildings data to the address Key-register. From 2011, all public bodies had to use this dataset.
  - The subsurface Key-register was accepted as an official key-register with a Decision from the Cabinet.
- 2009:
  - Obligatory use of the 10NL dataset by all governmental bodies came into force. This applies also to authorities that had their own 1:10000 topographic maps which had to be in line with the 10NL dataset by 2010.
  - The INSPIRE directive was transposed into Dutch law.

- 2010: Legislation for the large-scale topography (1:500 to 1:5000) was issued.
  The 1:50000, 1:100000, 1:250000, 1:500000 and 1:1000000 were also part of the Key-register for topography, and a covenant between the Ministry of VROM and the Cadastre was signed about the maintenance and registration.

4.3 Access to geoinformation and intellectual property rights

4.3.1 Copyright

Copyright is regulated by the Copyright Act of 1912, and the translation of the Directive of 2001 on Copyright in the Information Society into national law. According to those, copyrights are applicable to all governmental information. For commercial use of the copyrighted data, the consent of the responsible for the data agency must be provided. Same applies also to geoinformation.

Based on the Database law issued in 1999, the producer of a dataset who has been qualitatively and quantitatively investing in obtaining and maintaining the data is protected by the copyright legislation.

4.3.2 Restricted access and privacy

Personal data is protected in the Netherlands by:

- The Data Registration Act (1989)
- The Personal Data Protection Act which implements the EU Directive 95/46/EG and came into force in 2001
- The implementation of the Directive 2002/58 on privacy and electronic communication

The law on privacy is applicable to geoinformation because privacy issues occur when relating data to natural persons even if the focus is on the spatial aspect of the data and the data of the persons is anonymized. Particularly in the Key-register of buildings and addresses, data that can be considered as personal data can only be shared between organizations that are authorized to process personal data.

4.4 Funding and Pricing

In the first stages of implementing the NSDI, RAVI was funded by each participant and the Ministry of VROM with 1 million euros yearly for its coordination activities. These resources were invested into:

- Standardization
- Legal arrangements
- Defining the key datasets
- Raising political awareness
- Developing the knowledge infrastructure

Since 1980, Dutch governmental organizations are providing data based on a cost recovery model. The main providers of geographic information; the Dutch Cadastre, the Topographic Service and the Statistical Bureau are operating on this base. The Dutch Cadastre is supposed to cover its whole operational costs by selling the data, but is not allowed to make any profits. In 2007, prices were reduced due to good management of the expenses of the Cadastre. The Topographic Service and the Statistical Bureau are funded for their core activities, but are supposed to sell their data in order to increase revenues. In particular the Topographic Service has to recover 50% of the costs of production and dissemination.

For certain datasets (i.e. provincial data, Statistics Netherlands, water board authoritative data, the authentic register Building and Addresses etc.) the data is provided for free to the public sector and at minimum costs to the industry.

Geonovum received an average annual portfolio of 4 million euros for its activities. 25% of the funding was provided via 3-annual contracts with the Ministry of Information and Managements, the Cadastre, the Ministry of Economic Affairs, the Ministry of Interior, the Ministry of Defence and the Association of Provinces. The remaining 75% was provided via assignments.

For the implementation of the INSPIRE directive, the Ministry of Infrastructure and Environment received 0.5 million euros in 2008, 0.7 million euros in 2009, 0.7 million euros in 2010 and 0.75 million euros in 2011.

The Address and Buildings Key-register was financed by the Ministry of Housing, Spatial Planning and the Environment with 24 million euros for the investment, and from 2010 with 4 million yearly for the management expenses. Municipalities contributed their municipal budgets for covering their expenses.

The Topographic Key-register management expenses were 15.5 million euros in 2009, 14.5 million euros in 2010 and 13.5 million euros in 2011.

The investment costs of the Large scale standard map of the Netherlands were 19.2 million euros from 2009-2011 and its management expenses 18 million euros per year from 2009. It was financed by the public sector (10.8 million euros), national government contribution (7.2 million euros) and the Ministry of Housing, Spatial Planning and the Environment (7.2 million euros).

4.5 Key Initiatives

4.5.1 GIDEON

GIDEON was the first strategic plan for implementing the NSDI in the Netherlands. It was proposed in 2008 and had a duration of four years. The GIDEON document was the result of a joint activity between the GI-Council, Geonovum, RGI and the discussions in the Geo-meetings (Grus and Castelein, 2009). It determined the complete vision and implementation strategy for a fully functional NSDI in the Netherlands. The main phrase on which the GIDEON approach was built, was *"record once, use many times"*.

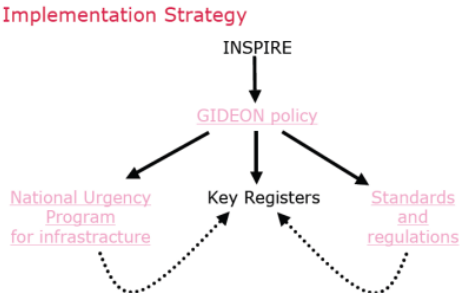


Figure 7: Key-register relation to GIDEON and INSPIRE (source: INSPIRE report 2011)

The GIDEON strategy is in line with INSPIRE and is basically built around the Key-registers concept (in Fig. 7).

The conceptual model of GIDEON can be seen in Fig 8. GIDEON is also cooperating with the services and eGovernment group.

On the policy level, the GIDEON policy is following the e-services policy framework, the policy document on the civil service reform (Nota Vernieuwing Rijksdienst)

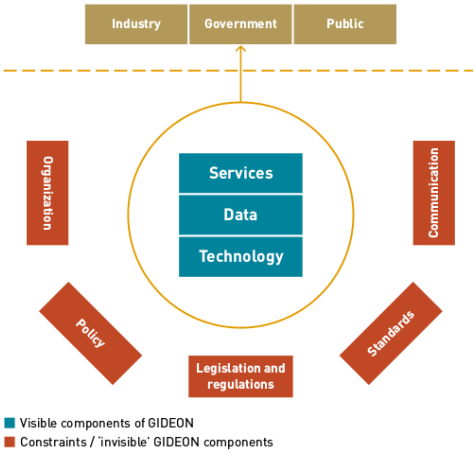


Figure 8: Conceptual model of GIDEON (source: GIDEON 2008)

and the National Urgency Programme (NUP), and aims at making geoinformation an important part of public services.

In order to increase the use of geoinformation, importance is given to implementing user friendly services. A communication strategy was developed by Geonovum and the eGoverment knowledge centre (ICTU) to promote the use of geoinformation and raise awareness. In addition to usability, interoperability is highlighted in GIDEON and achieved with the use of the geostandards framework for the Netherlands (see section 4.6).

The fact that building an NSDI is a matter of including multiple actors from different perspectives is underlined in the Netherlands by the huge number of organizations that were involved in forming the idea of GIDEON. These were:

- the Ministry of Housing, Spatial Planning and the Environment (VROM)
- the Ministry of the Interior and Kingdom Relations (BZK)
- the Ministry of Foreign Affairs
- the Ministry of Defence
- the Ministry of Agriculture, Nature and Food Quality (LNV)
- Government Service for Land and Water Use (DLG)
- National Service for Implementation of Regulations (DR)
- the Ministry of Transport, Public Works and Water Management (V&W)
- Directorate-General for Public Works and Water Management (RWS)
- the Netherlands Bureau for Economic Policy Analysis (CPB)
- GeoBusiness Nederland
- the Association of the Provincial Authorities (IPO)
- the provincial governments of North Brabant and South Holland
- Cadastre
- the Netherlands Environmental Assessment Agency (MNP)
- the Netherlands Agency for Aerospace Programmes (NIVR)
- the Netherlands Institute for Spatial Research (RPB)
- Geonovum
- Space for Geo-Information (RGI)
- the Netherlands Organization for Applied Scientific Research
- Alterra, the Association of Water Bodies (UvW)
- TU Delft, Utrecht University
- VU University Amsterdam and Wageningen University
- the Association of Netherlands Municipalities (VNG)
- the Municipality of Vlaardingen, Het Waterschapshuis

Coordinator of the project was the Ministry of Housing, Spatial Planning and the Environment (VROM) supported by the GI Council and Geonovum. In Table 2 the role of the involved parties is shown.

Table 2: Involved parties and responsibilities in GIDEON (source: GIDEON 2008)

Involved party	Role
Ministry of Housing, Sp. Planning and the Env.	Administration
GI Council	SDI owner/client • Facilitator • Strategy, policy and context setting
RGI	Catalyst for innovation • Knowledge building • SDI development • Promoting partnership
Geonovum	Knowledge centre • Translate policy into implementation • Facilitates national SDI
Public authorities	Implementing body of statutory duties • Services • Geodata user and supplier
Businesses	Created added-value chain
Data producers	Make geodata accessible • Make geodata integratable
Education	Knowledge transfer • Dissemination of knowledge
Research	Knowledge development • reflection
Users	Main role

The GIDEON document was officially accepted as a policy document by the GI-Council and the National Council for eGovernment Services in 2008 and after that it was accepted by the VROM. Subsequently, the Dutch parliament approved the document (Grus and Bregt, 2011). The progress of GIDEON is monitored in annual reports.

According to GIDEON, by having a Dutch NSDI:

- *the public and businesses will be able to retrieve and use all relevant geo-information about any location*
- *businesses will be able to add economic value to all relevant government-provided geoinformation*
- *the government will use the information available for each location in its work processes and services and*
- *the government, businesses, universities and knowledge institutes will collaborate closely on the continuing*

GIDEON is implemented by following a stepwise approach to construct the infrastructure while learning from already achieved results. Every six months the progress of GIDEON is being monitored and reported to the GI-Council.
GIDEON consists of three components: services, data, and technology (Table 3)

Table 3: Components of GIDEON (source: GIDEON 2008)

Services	Public (government)
	Market (businesses)
Data	Key geo-registries
	Thematic data
Technology	Extranet (government)
	Internet (public)

To realize the objectives of GIDEON seven implementation strategies were defined (Grus and Castelein, 2009):

1. *give geo-information a prominent place within e-services;*
2. *encourage the use of the existing four key geo-registers, and to set up two new ones;*
3. *embed the INSPIRE Directive into Dutch legislation and to implement the technical infrastructure;*

4. *optimise supply by forming a government-wide geo-information facility, which is to include geo-data standardization, new infrastructure, and collaborative maintenance;*
5. *encourage the use of geo-information in numerous government policy and implementation chains, such as safety, sustainable living environment, mobility, and area development;*
6. *create a favourable climate for adding economic value to available public authority geo-information*
7. *encourage collaboration in knowledge, innovation and education, for the permanent development and renewal of the key geo-information facility for The Netherlands.*

For each of these implementation strategies an implementation plan was described in the GIDEON document defining the objectives, milestones, involved parties and finance.

4.5.2 Key-Registers

Key-registers as a structured way of organizing spatial and non-spatial data had already been introduced in 1990. In 2011, following Key-Registers existed:

Spatial Key-Registers	Non-Spatial Key-Registers
Key Register Cadastral Parcels (BRK)	Municipal Register of Persons/Inhabitants (GBA)
Key Register Topography (BRT)	Key Register of Vehicles (BRV)
Key Register Addresses and Buildings (BAG)	Key Register Wages, Labour and Benefits (BLAU)
New Commercial Register (NHR)	Key Register Incomes (BRI)
Key Register Large-Scale Topography (BGT)	Key Register Value Immovable Property (WOZ)
Key Register Subsoil (BRO)	Registration Non-Residents (RNI)

as well as other national registers:

- Spatial plans (RO-Online)
- Recognized Restrictions Immovable Property (WKPB)
- Cables and Pipelines (KLIC).

The responsibility for each key register was distributed among the related authorities i.e. the Chamber of Commerce was responsible for the New Commercial Register, the municipalities for the Municipal Register of Persons/Inhabitants register etc.

All public-sector organizations were obliged to use the data from the Key-registers and were encouraged to contribute to their quality by pointing out errors and misconceptions (Bakker, 2011). By establishing the Key-registers, data duplications were reduced. The Key-register Topography became openly available in 2012, and an agreement was made for the Key Register Cadastral Parcels stating that the data would be provided free of charge to all

governmental bodies. The Key-registers led to 25% less bureaucracy and the reduction of 30.000 governmental databases.

4.5.3 PDOK

The "Maps for Services (Publieke Dienstverlening op De Kaart (PDOK))" project, initiated by the Dutch Cadastre, Land Registry and Mapping Agency (Kadaster) in 2007 and driven by the force of implementing the INSPIRE Directive, targeted at providing a centralized infrastructure for sharing geographic information in the Netherlands (Fig. 9). In 2008, the financing of the project within the Civil Service Reform Program by the government was approved.

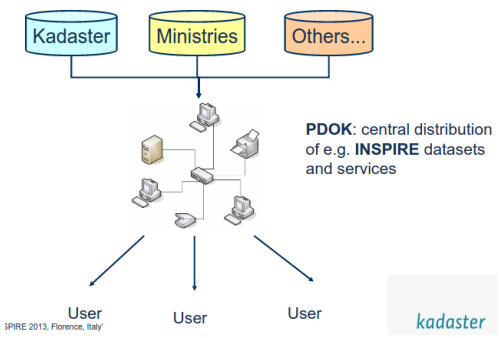


Figure 9: PDOK infrastructure (source: Haico van der Vegt, 2013)

As described in the Annual Report of the Cadastre in 2011, the project became very prominent and resulted in being a joint activity of the Ministry of Infrastructure and the Environment, the Directorate-General for Public Works and Water Management, the Ministry of Economic Affairs, the Cadastre and Geonovum. Additional partners were the National Service of the Implementation of the Regulations of the Ministry of Agriculture, Nature and Food Quality and the Dutch Organization for Applied Scientific Research.

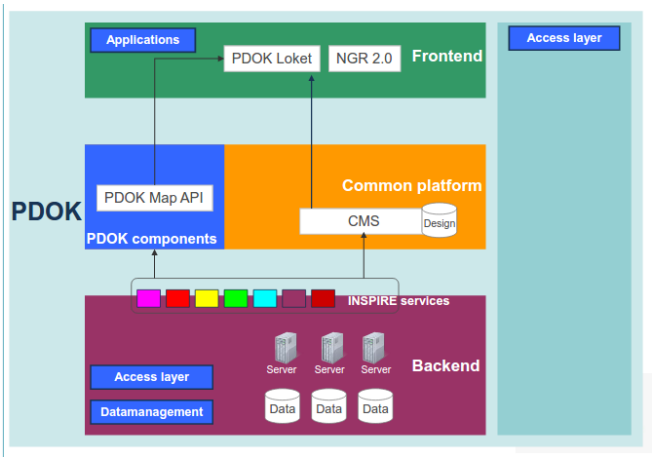
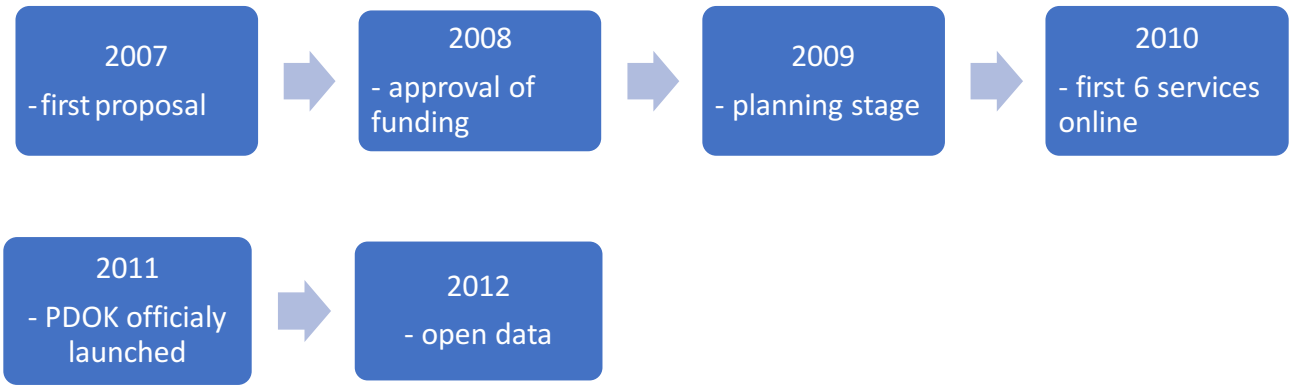


Figure 10: PDOK architecture (source: Haico van der Vegt, 2013)

PDOK was developed within four years with a funding of 9 million euros. It is part of the NSDI and based on the INSPIRE requirements. It has a scalable architecture



mainly based on open source and open standards and is in line with the eGovernment architecture. The PDOK architecture is seen in (Fig. 10).

Geonovum was the strategic advisor, and the Cadastre was responsible for developing and maintaining the system while the whole approach was linked to the GI-Council (Fig. 11).

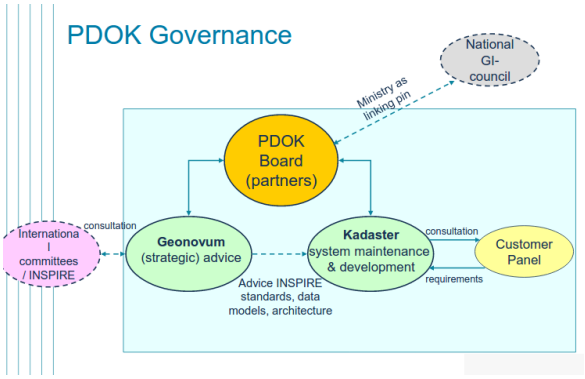


Figure 11: PDOK organizational structure (source C. Groot, Athens workshop on NSDI, March 2017)

In 2013, the PDOK portal had already 42 national datasets and over 5 million map requests per month. High quality metadata is providing descriptions of the data in PDOK. According to the PDOK business model the data providers paid 4 years' partner funding. For complex dataset, variable pricing models existed. For simple datasets 3000 – 5000 euros per year had to be paid with a discount policy for very small datasets. The data usage was set free of charge (van der Vegt, 2013).

4.5.4 Ruimtelijke plannen (RO-Online)

Spatial plans are made available in digital form via the Ruimtelijke plannen portal. From 01.01.2010 governmental agencies are legally obliged (by the Law of Spatial Planning) to digitize and make spatial plans available via the portal. The Cadastre is responsible for the system and the helpdesk and Geonovum is responsible for managing the domain standards and communicating with the stakeholders.

4.5.5 INSPIRE

The INSPIRE Directive which came into force in 2007 and was accepted by GIDEON as one of its seven strategies, can be seen as the driving force and the triggering power for implementing the NSDI. The Ministry of VROM was the overall responsible Ministry for the implementation and Geonovum had the execution role of the technical implementation and organization. Geonovum was also responsible for consulting and training activities and meetings.

The basic guidelines for the implementation as set by the Parliament were that:

- the effort for the implementation shall be kept as low as needed
- the Key-registers and other national data infrastructures have to be reused as much as possible

The implementation phase started with the proposal of three implementation models:

a) the basic model according to which only one organization would be responsible for providing and maintaining data for each INSPIRE theme
b) the intersection model according to which many data providers would cooperate and provide one dataset per theme
c) the collective model according to which many data providers would be able to provide data to the same theme.

Finally, the basic model was chosen. This choice was also supported by a cost benefit analysis of the adoption of INSPIRE in the Netherlands.

In a study, both the basic and the collective model were investigated as well as the option of rejecting the INSPIRE directive. Both the basic and the collective model showed great benefits from implementing INSPIRE.

Particularly for the basic model, the costs were 32.1 million euros while the benefits were 66.1 million euros within 15 years. Until 2013 the costs were expected to be higher than the benefits, a tendency that would turn conversely from 2014. After 2018, it is expected that the costs made for implementing INSPIRE will be recovered. For 2011 and 2012 the cost for guidance and coordination were 1.25 million euros per year and for 2013 and 2014 1.05 million euros per year.

Organizations providing data to INSPIRE were (Fig. 12):

- National Government (ministries, cadastre, statistics, geological survey, chamber of commerce etc.)
- Regional governments (12 provinces and 24 water authorities)
- Local government (403 municipalities) (Groth, 2014).

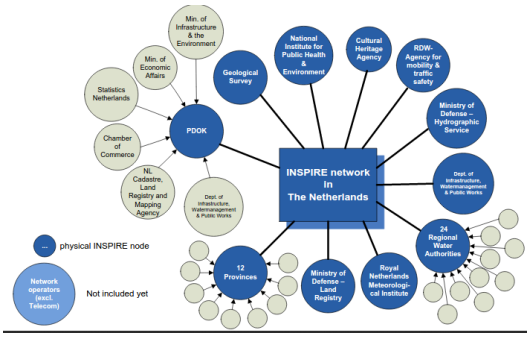


Figure 12: INSPIRE data providers (source :https://ec.europa.eu/jrc/sites/jrcsh/files/Geonovum_GRothe_SDI_Open_Data_Netherlands.pdf)

85% of the INSPIRE themes had been already covered by the national datasets. The existence of the PDOK approach and the Key-registers made the implementation of the INSPIRE directive in the Netherlands less cumbersome. In

Fig. 13, the relation between the national infrastructure and the INSPIRE portal is shown.

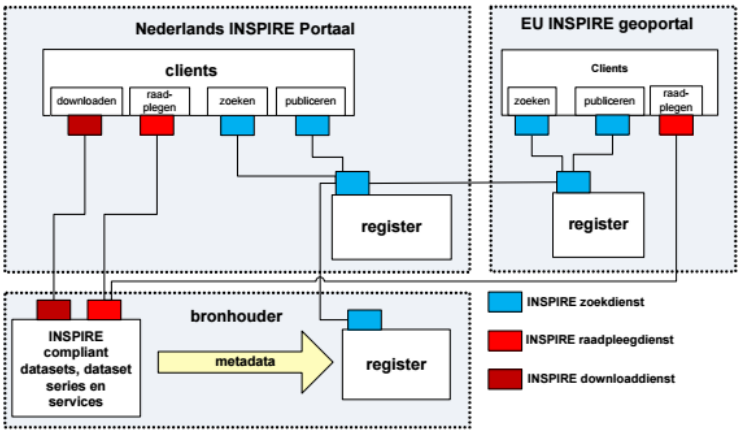


Figure 13: Relation between national an European INSPIRE geoportal (source: http://inspire.ec.europa.eu/reports/country_reports_mr2012/NL-INSPIRE-Report-2013_ENV-2013-00445-00-00-EN-TRA-00.pdf)

4.6 Standards

In 2005, a framework for standards to be used within the Dutch NSDI and for connecting the Dutch NSDI to the European SDI (ESDI), was introduced. The framework was divided into standards for:

- metadata
- information models
- services

Standards for metadata are used for discovery, exploration and exploitation and follow the guidelines of "Advies Overheid", of the Dutch government (they are based on the Dublin Core standards metadata element for information and documentation (ISO15836)).

For information models in the spatial domain, the Base Geo-Information model was developed. It is a three-layer model (Fig. 14) and its main goal is to enable cross institutional sharing of information without information loss. This model is still in use nowadays.

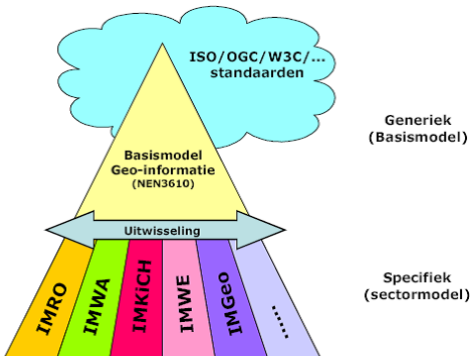


Figure 14: Information model standards architecture (source: C. Groot, Workshop on NSDI, Athens, March 2017)

Domain Information models in use are:

- NEN3610:2005 base model Geo-information
- IMRO:2006 Spatial Planning
- IMWA:2006 Water
- IMKiCH:2006 Cultural heritage
- Top10NL small scale topography (1:10000)
- IMWE:2006 Regulations on the external appearance of the build environment (in dutch "Welstand")

- IMGeo Large Scale Topography
- IMBOD Soil and geology
- GRIM the “green space” (Agriculture, nature, recreation etc.)
- GBR: first draft information model on the organizational level made for Rijkswaterstaat, the Dutch Directorate for Public Works and Water Management

For services, the ISO 19119 standard was used. Services are following the Service Oriented Architecture with two types of services

- Request-respond
- Publish-subscribe

The international standards from OGC, W3C, OASIS and profiles of WS-I are used and national profiles are developed for WMS, WFS, WMS/SLD.

A national validation service for spatial planning standards was developed by Geonovum and made available in 2008. The service tested the spatial plans in four levels:

- *Test 1: ensures that GML data encoding is according to the schemes and business rules of the standards*
- *Test 2: controls if all file names are used properly*
- *Test 3: controls if the geometry is interoperable with GML standards and GIS/CAD systems’ requirements*
- *Test 4: controls if the digital signature is valid to ensure the integrity and completeness of the plan*

At about the same time (2007) on the governmental level open standards were used. With the action plan “The Netherlands Open and Connected (Nederlands Open In Verbinding - NOIV)”, open source and open standards were promoted (Heemskerk, 2007). The Program for Open Standards and Open Source Software in Government (OSSOS) was completed in 2011.

For the implementation of INSPIRE, Geonovum has released the ‘Framework for standards’ to assist the technical implementation. In this document the metadata, architectural element, service elements and information that were already in use were related to INSPIRE standards.

Geonovum has released the National Georegister, a metadata catalogue where users can search for metadata using keywords, accuracies, area, theme and/or producer of the dataset. This metadata catalogue is strongly based on the ISO and OGC standards. Another metadata catalogue is maintained by the Water service of Directorate-General for Public Works and Water Management.

5. The NSDI today

The NSDI in the Netherlands is well developed and functioning nowadays. On the organizational level roles and responsibilities are set, the legal aspects are defined, and the community is built. The Ministry of Environment and Infrastructure is the overall responsible body for the NSDI and is supported by Geonovum and the GI-Council. The INSPIRE Directive is fully implemented.

PDOK is the one stop shop for geospatial data. The National Georegister is the central metadata catalogue. PDOK, the National Georegister and the INSPIRE portal are integrated. Key-Registers as the official source of authoritative data are the backbone of the NSDI. A strong open data policy is implemented and most of the data particularly in PDOK are provided open and free. Validators and quality control measures are applied to the Key-registers.

International standards are widely used and Geonovum plays a pivotal role in supporting the use of them and educating the users. On the technological level, a Service Oriented Architecture is adopted and open source, open standards and open licences are highly promoted. Following technological advancements, linked open data and 3d information systems are introduced.

The NSDI is used cross institutionally. High level of user engagement is observed either with the use of crowdsourcing mechanisms for data improvements (i.e. user feedback on PDOK portal) or with the collaboration of the public sector, the industry and academia in forming the vision of the next NSDI (GeoSamen).

6. The five elements of the NSDI: Organization, Standards, People, Data and Technology

6.1 Organization

The Ministry of Environment and Infrastructure is the overall responsible body for the NSDI in the Netherlands.

Geonovum is the SDI executive committee and coordinating body. It is the representative of the Dutch geoinformation community, it is involved in the standardization process and in communicating the use of the standards

It is in charge of developing and maintaining the national geoportal as well as the operational aspects of INSPIRE and it plays an important role in international networking. The political responsibility of Geonovum lays in the Ministry of Environment and its funding is covered by the Ministry of Environment and Infrastructure, the Ministry of Economic Affairs, Agriculture and Innovation, the Cadastre and the Geological Survey.

The GI – Council consists of representatives from all the ministries involved in the NSDI. The GI-Council is focusing on strategic advisory duties. It has a coordinating role. The implementation strategy of GIDEON, drafted by Geonovum and RGI was requested by the GI-Council.

Geomeetings is a type of forum in which industry, geo professionals and academia meet.

The central portal of the Dutch NSDI is PDOK. It is connected to the INSPIRE portal and the National Georegisters (Fig. 15) (more information about the technical infrastructure is provided in section 6.4).

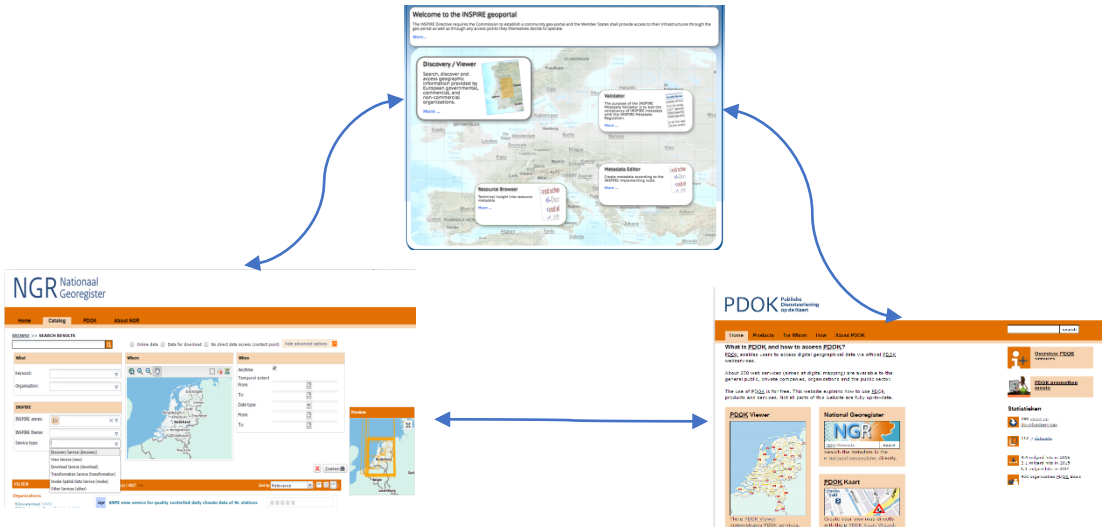


Figure 15: Relation of PDOK, National Georegister and INSPIRE portal (source: PDOK portal, NGR portal, INSPIRE portal)

6.1.2 Legislation

Sharing geographic information in the Dutch NSDI is following the national and European legal acts. Geoinformation falls under the laws that concern privacy issues (i.e. EU Directive 95/46/EG which came into force in 2001 and EU Directive 2002/58 on privacy and electronic communication adopted in April 2004), the public access of governmental information (i.e. the Government Information Public Access Act of 31 October 1991 and its revision to include the implementation of Directive 2003/98), environmental law (i.e. the adoption of the Directive 2003/4 in the national law), the Dutch Data Registration Act and the Dutch Open Data Policy.

In Appendix 1, a complete list of legislations can be found.

6.1.3 Governance

The Ministry of the Environment and Infrastructure is the overall responsible body for the NSDI in the Netherlands. The GI-Council has the SDI ownership and the Cadastre has the legal task for managing the key geo-registration and the National Georegistry. National agencies, provinces, municipalities and waterboards are in charge of:

- Legal tasks in geoinformation production
- Public sector tasks in data production
- Integration of geoinformation in eGovernment businesses

Geonovum is responsible for the realization of the SDI and functions as a knowledge centre for geo-standards.

6.1.4 Policies and Licensing

6.1.4.1 Policies

In the Netherlands, there is a clear open data policy that was realized in 2011 with the online Dutch open government data portal (https://data.overheid.nl/) by the Ministry of the Interior. Open data is conceptualized as “all data must be open unless....”. Unless implies the restriction given by national (Government Information (Public Access) Act) and European law (Re-use Directive, INSPIRE, Aarhus Treaty) concerning privacy issues. On yearly reports the open data strategy is monitored.

PDOK, the central portal for sharing geoinformation (see section 6.4.1) has a defined policy on the terms of use for certain target groups (Fig. 16).

PDOK Basic is used within the public sector following registration of the organization with PDOK. Sufficient capacity for large scale processes and a guaranteed level of service and support is provided at this level. By using PDOK Basic, an organization is compliant with the Dutch and European policy on open data and INSPIRE.

PDOK Educational is used freely and unlimited within the education sector after registration by the educational institution. In cases of great demand of services on the PDOK Basic level, the capacity and performance of service provision on the PDOK Educational level decreases.

PDOK Fair Use provides to everyone open access to all data and service without registration. The usage is free but the available capacity for PDOK Fair Use is limited as the focus is given on PDOK Basic. Therefore, it is not suitable for critical business processes.

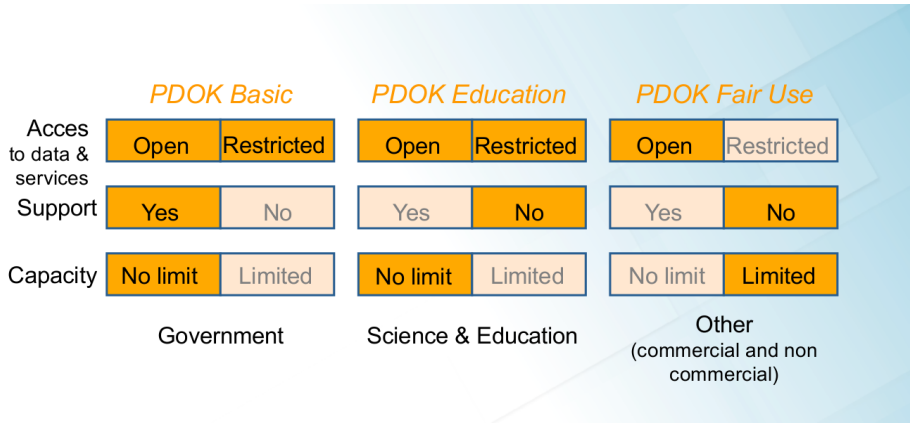


Figure 16: Terms of use of the data for certain target groups (source: C Groot, Workshop on NSDI, Athens, March 2017)

Particularly for privacy issues, Geonovum has developed an online diagnostic tool, which provides feedback about how a dataset can be used in a question answering process.

Specific ICT-Digital government policies and open data policies are listed below:

Geo-information

- GeoSamen (2014-2020) Vision by developing geo-information sector Netherlands, successor policy GIDEON
- Policy paper GIDEON - Basic geo-information Netherlands, vision and implementation strategy (2008-2012)

ICT – Digital Government

- Letter to I-strategy Empire
- Report Digital Implementation Agenda Netherlands (Ministry of Economy)
- Digital AgendaNL
- Open standards, open source and open data
- E-Government
- Web Guidelines
- Strategic Knowledge and Innovation Agenda: IenM makes room

Re-use of Public Sector - open data

- Open data and open standards (Rijksoverheid.nl)
- The value of open data. Choices and impact of open data strategies for public organizations
- Creative Commons unless (adopted November 20, 2014)
- Declaration of Intent statements provinces and water: supply and reuse of geographic information

6.1.4.2 Licensing

Most of the geodata is provided openly and freely under open licences. The main licenses are:

- the "creative commons public domain mark" according to which data made available by the Public Domain Mark, can be used by anyone for any purpose.
- the "creative commons zero license" according to which data available with the Creative Commons Zero Statement (CC0), can be used by anyone for any purpose.
- The "creative commons unless" according to which the government is making all the data available unless specific terms of use are provided that are not fulfilled by the creative common licenses. The "creative common unless" policy was adopted by the GI council in 2014.

Due to the limitations and difficulties of the creative commons licenses when applied to the geoinformation sector, Geo-gedeeld was introduced. Geo-gedeeld is a framework to express terms of use for geo-information in a simple, clear and standardized way. It is based on the creative commons framework and is proposed by Geonovum and the Delft University of Technology.

Geo-gedeeld is based on several standard conditions for use. Each condition has an individual icon, layman's wording and legally binding text. In a user-friendly interface (Fig. 17) the data owner determines which of the conditions of use are applicable to their data or services. This information is attached to the data and recorded in National Georegister, the national metadata catalogue for data and services.

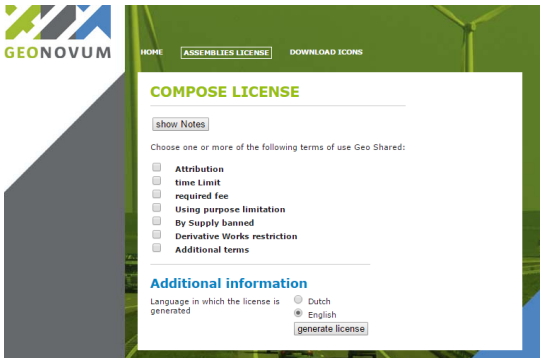


Figure 17: Geo-gedeeld interface (source: http://geogedeeld.geonovum.nl/samenstellen/)

6.1.5 Partnerships

6.1.5.1 GeoSamen – Partners in Geo

GeoSamen (2014-2020) is a shared vision for geoinformation and a continuation of the GIDEON policy (2008-2011). The scientific community, the private companies and the public-sector function as "Partners in Geo" and in a collaborative manner adopt to the advances in the geoinformation sector such as real-time high quality geodata, three-dimensional data, real time data availability for everyone to use. GeoSamen is not undertaking operational activities but is very active on the strategic and tactical level.

Within GeoSamen the role of the public sector is to create the preconditions of the open public data infrastructure. The role of the private companies is to develop innovative products and the role of the scientific community is to expand the technological possibilities.

6.1.5.2 Centre for Spatial Law and Policy

The Centre for Spatial Law and Policy is a cross national and cross institutional organization that has been established to better understand how legal, policy and regulatory issues limit the collection, analysis, storage and distribution of geospatial information. The Centre's mission is to help remove these barriers at the local, national and international level in order to help facilitate the sharing of geospatial information that is critical to address important international issues. Since these issues cut across technology platforms and legal disciplines, the Centre is developing partnerships with industry, government, NGO's, research institutes and transnational organizations.

6.1.5.3 NORA - The Dutch Government Reference Architecture

Efficient functioning of the public sector is achieved when governmental organizations and agencies cooperate well with each other. The main challenge is to harmonize the processes and make data and services interoperable. NORA is the Dutch Governments' reference architecture for defining the principles of the cooperation. It provides a framework for making inter-organizational arrangements simpler. It also provides basic principles for the design of processes and systems with the view to reaching conceptual and technical interoperability.

6.1.5.4 Open Government Partnership

The Open Government Partnership (OGP) is an initiative launched by the US and UK. The initiative's goal is to encourage governments to be as "open" as possible and render transparent account for their actions. Sixty-three countries, including the Netherlands, are currently participating in the OGP.

6.1.6 Audit

The Algemener Rekenkamer (Court of Audit) is a "High Council of State" of the Netherlands; a central government body responsible for controlling whether central government revenue and expenditure are received and spent correctly and whether central government policy is implemented as intended. Among a high number of themes that are controlled, two are dedicated to geo related information (Table 4).

Table 4: Auditing themes and subthemes related to geoinformation (source: http://www.courtofaudit.nl/english/Themes)

Environment, Agriculture and Nature Nature	**Space and Mobility**
Climate and Energy	Housing
Pollution	Spatial planning
Agriculture	Infrastructure
Nature	Transport

6.1.7 Pricing and Funding

For the development of the PDOK between 2008-2012, 18 million euros were invested. For Geonovum related funding and INSPIRE funding (see section 4.4).

From 2013, the yearly budget of PDOK is 3 million euros per year including maintenance of the platform as well as hardware, software and further development of services. The detailed funding schema can be seen in Fig. 18. The development and maintenance costs of the National Georegister are included within those numbers and are approximately 10% of the whole budget.

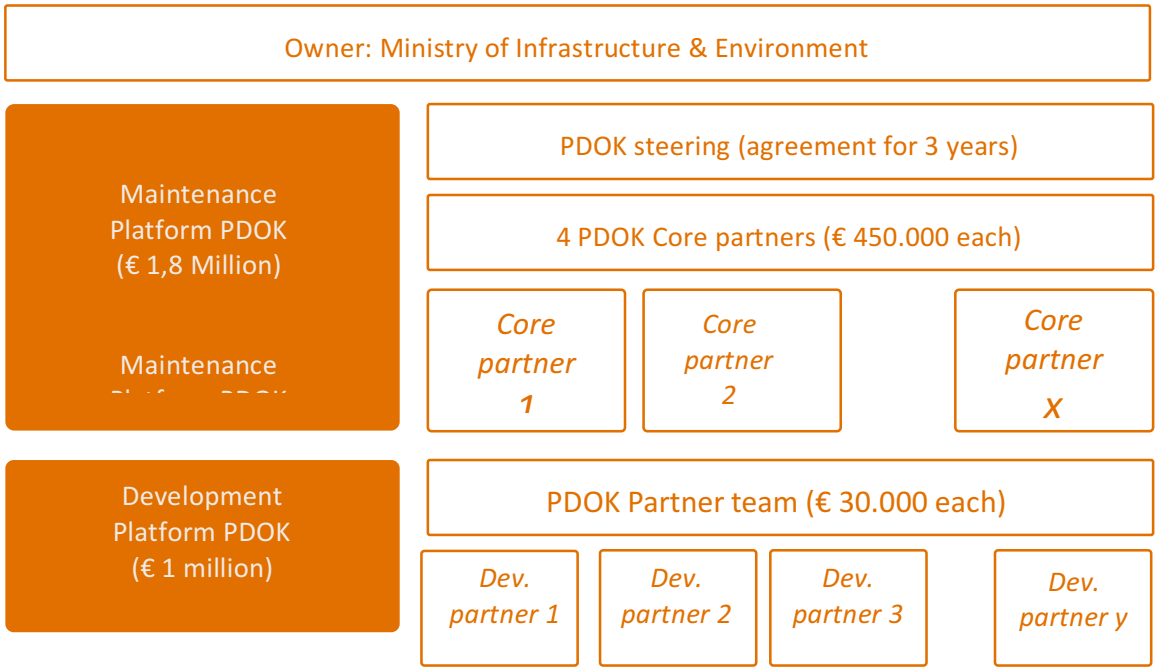


Figure 18: Costs of developing and maintaining the PDOK portal (source: C. Groot, Workshop on NSDI, Athens, March 2017)

All data on the PDOK portal is free and open without any pricing and licensing restrictions.

6.2 Standards

ISO 19000, OGC and W3C standards are used for metadata, information models and network services as well as INSPIRE compliant geo-standards. For the high-level features such as buildings Geonovum has developed information modelling standards and glossaries that are creating a common understanding and are used in the same manner in all datasets (Groot, 2017). In this sense IMGeo (Eekelen, 2011) has been developed. The sector model is shown in Fig. 19. GityGML is used for the 3d information in the Netherlands (Stoter and van den Brink, 2013). Geostandards are harmonized with NORA.

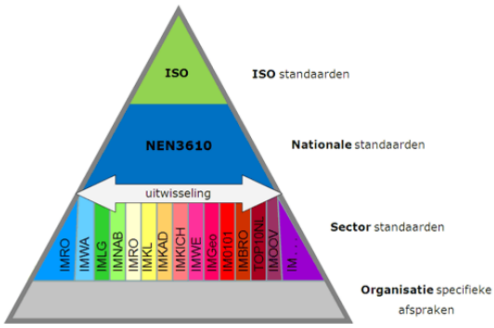


Figure 26: Framework of standards (source: https://www.geonovum.nl/onderwerpen/basismodel-geo-informatie-nen3610/algemeen-basismodel-geo-informatie-nen3610)

In order to assist users in choosing the correct standards the framework for geostandards was published by Geonovum.

Additionally, The Standardization Forum which was established in 2006 by the Ministry of Economic Affairs, has an advisory role on the use of open standards. It also manages the open standards (not only geo standards) that are supposed to be used in the public sector

An overview of all the geostandards being used in the Dutch NSDI, is provided in Appendix II.

6.3 People

6.3.1 Skills and qualifications

The Dutch NSDI can be regarded as a very user oriented NSDI architecture. The goal from the very beginning was to focus on citizens and entrepreneurs to develop the NSDI in a customer friendly way.

In the Dutch NSDI, professionals from different domains are cooperating with each other such as policy makers, project managers, land surveyors, ICT professionals, lawyers, public servants etc. Although the technical infrastructure is very advanced, it is maintained and developed by approximately 10 employees.

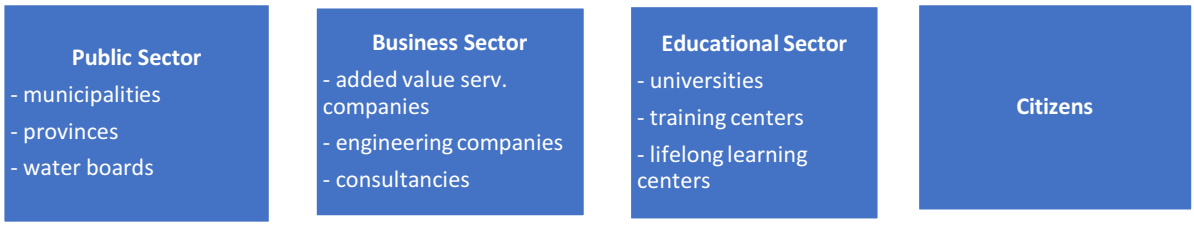
On the academic level, following institutions are very active in the geoinformation sector: ITC Netherlands, the Vrije University, Delft University of Technology, Wangeningen University, Utrech University, University of Twente, UNESCO IHE Institute for Water Education.

A lot of workshops and training activities organized by Geonovum have helped in gaining knowledge and building the community. Similarly, the Cadastre carries out international

activities in the fields of education, teaching and research. User representatives and data providers meet regularly.

Since 2014, the topographic map 1: 50.000 (TOP50NL) is automatically retrieved from the map scale of 1: 10,000 (TOP10NL). This method is internationally well accepted. Through multi-day seminars knowledge and experience on this field has been shared with topographical services of other countries such as Switzerland and Sweden.

Users and people benefiting from the NSDI are active in following sectors:



6.3.2 Social Responsibility

Netherlands' Cadastre, Land Registry and Mapping Agency - in short Kadaster[3] applies Corporate Social Responsibility (CSR) business principles. It is responsible for the central facilities (maintenance and distribution). It is also responsible for the Key-Register for Addresses and Buildings, the TOP10NL, which was made available as open data in 2012, the Key-register Large Scale Topography (BGT) and the digital cadastral map which was made available as open data in 2016.

As a state-owned organization, it focuses on creating value for society. This means that products and services are implemented in such a way that they contribute to social wealth. The cost-effective execution of the tasks is an important precondition. To accomplish this, low-risk financial policies are applied.

Within the organization (with 1673 fte's) modern employment practices are applied including knowledge and skills development and diversity (gender, age, etc.) of the employees. A good working environment leads to better motivated employees and better quality of service. In line with the participation law, the Cadastre is committed to employing people with disabilities with an expected increase of number from 9 (2016) to 25 (2020).

6.3.3 Culture

The Netherlands has a very strong culture on open and eGovernance which is also reflected in the geoinformation sector. Key-registers as the authoritative source of high quality geodata is mandatorily used within the public and private sector. Collaborations are not only captured

[3] Cadastre is used throughout the text referring to Netherlands' Cadastre, Land Registry and Mapping Agency

between different domain (i.e. SDI for disaster management), or municipalities (i.e. Dataland project) but also crossnational (joint SDI with NRW).

A very strong culture on open and eGovernance is supported also by legal Acts and technical solutions. The active involvement of the users (crowdsourcing) (i.e. in the PDOK portal) and the joint effort of building the vision for the future NSDI (GeoSamen) reflect the high level of spatial literacy and cooperative culture of the Dutch.

6.3.4 Communication channels

- PDOK notification system
- PDOK news feeds
- Geonovum helpdesk
- Dutch INSPIRE Interest Group forum
- Mijn Kadaster - personal login
- Kadaster notification system

6.3.5 Citizens' involvement – crowdsourcing

6.3.5.1 Making Sense for Society Platform

In 2014, the open platform "Making Sense for Society" was launched. Its goal is to explore the use of citizens' data (citizens as sensors) within the government. The project is looking at technical issues such as data acquisition, storage and fusion as well as policy (open sensor data, real-time monitoring), governance and privacy.

6.3.5.2 PDOK forum

Users of the PDOK portal can point out errors and gaps in the data as well as general recommendation on the PDOK forum (Fig. 20). Administrators are then processing the comments and making changes and improvements if applicable.

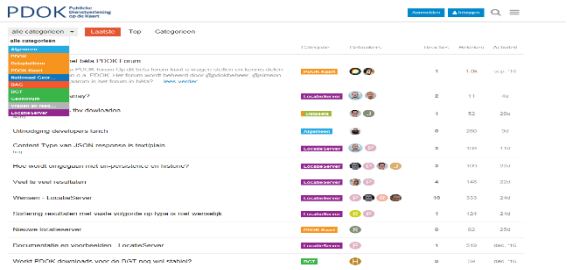


Figure 27: PDOK Forum (source: C. Groot, Workshop on NSDI, Athens, March 2017)

6.3.5.3 Feedback Mechanism - Topography Register

For the Topography Register, users can submit their comments and map changes via a feedback mechanism. Employees at the Cadastre are evaluating the incoming messages and updating the maps.

6.3.5.4 Geodag

Every two years the open Geodag is organized by Geonovum. In workshops, presentations and networking activities the latest developments are represented and discussions are promoted under the *"catch up in one day"* statement.

6.4 Data

6.4.1 The PDOK Portal

The central portal for the NSDI in the Netherlands is PDOK. It is developed as a scalable infrastructure easily adaptable to future growth. The data is provided either as downloadable files or web services. The responsibility for the creation, maintenance and quality of the data stays at the producer side.

The Cadastre is responsible for the technical aspects of the portal and the user support. Geonovum has an advisory role. A steering board is responsible for monitoring the quality and assure the participation of all organizations. A great communication channel exists with the user community that gets notified on any changes to the portal or technical problems.

All data on PDOK is provided under an open license which means that data is free to use in accordance to the Dutch "Fair Use Policy". Some datasets and services though, are not open for example due to privacy laws such as the cadastral map (except boundaries), the Key-register buildings and addresses and the cables and pipelines dataset or in the case of purchased image material, this is only available to the partners that have contributed shared amount of money. Three level of use exist: PDOK Basic, Educational and Fair Use is used (see section 6.1.4.1).

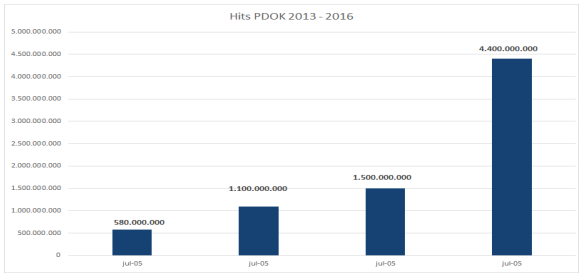


Figure 28: PDOK hits 2013-2016(source: C. Groot, Workshop on NSDI, Athens, March 2017)

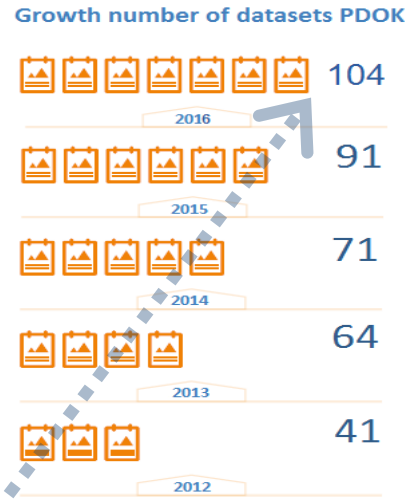


Figure 29: PDOK number of datasets (source: C. Groot, Workshop on NSDI, Athens, March 2017)

An increase in hits has been observed between 2013 and 2016 (Fig. 21). Particularly for the first quarter of 2017 more than 400 million hits per month were measured. In present, 104 datasets, more than 51 INSPIRE datasets and 288 view- en download services are available on PDOK. The increase of the number of datasets can be seen in Fig. 22.

The PDOK portal is implemented wholly based on open source software.

6.4.2 Key-Registers

SDI developments in the Netherlands are strongly related to the eGovernment Key-registers. These are part of Dutch Law and consist of an interrelated system of registrations (Fig. 23). The foundational data (or Key-registers) are divided into spatial and non-spatial:

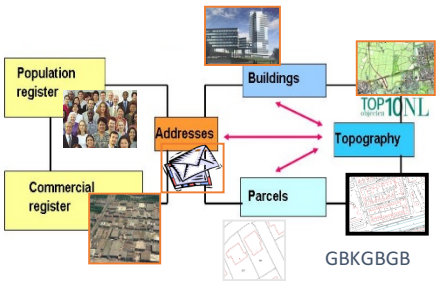


Figure 30: Connection of spatial Key-registers (source: C. Groot, Workshop on NSDI, Athens, March 2017)

Spatial Key-registers

Key Register	**Responsible**
Cadastre BRK	Cadastre
Topography BRT	Multiple Governmental Organizations
Addresses and Buildings BAG	Municipalities
Large Scale Topography BGT	Cadastre
Real Property Value WOZ	Municipalities

Table 5: Key-register responsible authorities (source: https://www.kadaster.com/)

Examples of non-spatial Key-registers are: Population, car licence plates, income.

The contribution to these foundation data is mandatory. The aim is to provide a central data source for the complete government. Within the government the use of the Key-registers is compulsory. Responsibility is shared between the data providers (Table 5).

By maintaining the key-registers there is a bureaucracy reduction of 25% and reduction of 30000 governmental databases. Frequent update of the data, even daily particularly for cadastre (BRK) and buildings (BAG), minimizes the need for downloading and locally stored data versions. The latest versions can be directly retrieved from the portal.

By having the Key-registers the implementation of INSPIRE was easily made. All governmental organizations that maintain geodata can be involved in INSPIRE. For data distribution, the central facility can be used.

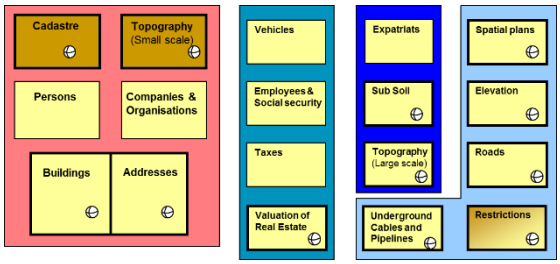


Figure 38: Key-registers and non-official registers (source: C. Groot, Workshop on NSDI, Athens, March 2017)

Except for the official Key-registers, some other nationwide registers exist (blue parts in Fig. 24). These won't be upgraded to Key-registers but can be accessible in a uniform way.

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6.4.3 National and Regional Portals

Spatial data is also shared via national and regional portals

National Portals

- Atlas Environment government information about the quality of the physical environment
- Central Statistical Bureau statistical datasets, including population centres geographic datasets and district and neighbourhood map Netherlands
- Data.overheid.nl open data portal of the Dutch government
- DINOShop portal for geo-scientific data on the shallow and deep subsurface of the Netherlands
- Energy Sector data collections in the energy industry in the Netherlands
- Geo4OOV.nl portal for the Public Order and Safety sector
- Atlas Leefomgening portal for the living environment
- Geoportal Water Boards portal of the water boards
- National Space Office Satellite Data Portal
- OPOC web and downloads data records of Dutch government organizations, including the geographic base registrations
- Provincial Georegistry Web services and downloads of the Dutch provinces
- Ruimtelijkeplannen.nl portal with zoning, structural concepts and general rules created by municipalities, provinces and the central government
- Klic – online portal for cable and pipeline information

Regional and Municipalities Portals

- Open data Amsterdam
- Open data Enschede
- Open data Overijssel
- Nijmegen open data
- Zwolle geo-information portal

6.4.4 Quality Aspects

System validators are used to control if data and services are in accordance with standards. By using the validator, data and services are checked again established standards and profiles and a direct report of the findings is submitted to the user. Validators are managed by Geonovum. In Appendix III, a list of the available validators is provided.

Quarterly, Geonovum monitors the quality of the Dutch metadata. This is performed based on the 26 elements described in the metadata standards. All the elements are rated and in order to conform to the standard and least 82 points in the case of data sets at least 78 points for services have to be reached.

For the Key-registers special quality control measurements are undertaken. For the Key Register Topography (BRT) the Cadastre continuously monitors the quality of the files and reports the results (i.e., Report 2014) by randomly investigating 5% of the areas. Based on legally defined requirements, every three years the data is audited by an external party. The audit is made on the logical consistency, positional accuracy, timeliness, completeness and thematic accuracy of the data. Alterra research institute was the external audit party in 2012 and 2015.

For the Addresses and Buildings Key-register the Cadastre controls the data and publishes the results in the Quality bag 2011-2014 report. Since 2016, there is also a quality dashboard available for data providers and users.

By enabling crowdsourcing activities in the PDOK portal, users can comment on the data quality by posting errors and misconceptions that are then assessed by the administration team.

6.4.5 Metadata

The National Georegister (NGR) is the central metadata portal for geoinformation in Netherlands. Map and keyword based search functionalities are provider. Datasets can be previewed on a map and directly downloaded. The metadata from NGR is automatically connected to the central open data portal data.overheid.nl. Therefore, the data must be published as open data using the public domain license, the Creative Commons Zero (CC0) or creative commons - attribution required (CC-BY) license.

The National Georegister is connected to the PDOK portal and can be directly queried from there. The metadata can be accessed by a CSW (OGC Web Catalogue Service). All metadata is provided free of charge.

The actual data themes in the NGR portal and the related number of datasets can be seen in Table 7.

Table 6: Data themes in the National Georegister portal

Data theme	Number of Datasets
civil structures	272
backwater	522
economy	181
geo scientific data	230
health	144
boundaries	443
elevation	5053
land cover	110
transport	845

Data theme	Number of Datasets
climatology, meteorology atmosphere	116
agricultural	199
location	362
company	422
military	15
nature and environment	1652
utilities communications	97
ocean planning	59
cadastre	411

Metadata is provided based on ISO 19000, OGC and W3C standards. Additionally, Geonovum has developed Dutch metadata frameworks based on ISO standards to promote interoperability within the Netherlands. These profiles are:

- datasets: Dutch metadata profile on ISO 19115 for geography v1.3
- datasets: Dutch metadata profile on ISO 19115 for geography v1.3.1
- Services: Dutch metadata profile on ISO 19119 for Services v1.2
- Services: Dutch metadata profile on ISO 19119 for services v1.2.1

The Dutch profiles are aligned to the INSPIRE metadata profiles .

A great number of guides and manuals on metadata has been published by Geonovum and a wiki is available.

6.4.6 Open Data

Within the Dutch government, the Ministry of the Interior and Kingdom Relations (BZK) is responsible for open data.

The government published in 2013 the 'Strategic Vision on Open Data' and the associated 'Open Data Action Plan'.

Ministries had different strategies and resources to open up their data. In general, open data account for only a very small fraction of a ministry's expenditure, on average 0.01%. The staff costs for open data are less than 0.14% of the total number of Full-Time Equivalents (FTEs)

and usually 0% as staff are not employed specifically for open data. Particularly for the Ministry of Environment and Infrastructure the costs of opening up the data were very low as the publication of open data was part of the primary work process.

Table 7: Costs for opening up the data (source: The Green Land, 2014)

	Initial cost as a % of total costs	**Annual costs as a % of total costs**	**Total expenditure of organisation in initial year (in millions of euros)**
Cultural Heritage Agency	0%	0%	39
Enschede Municipality	0.002%	0%	741
Rotterdam Municipality	0.001%	0.001%	4428
Kadastre	0.031%	0.010%	239
Netherlands Meteorological Institute	0.087%	0.024%	58

According to the Open Data Barometer particularly for Map data, the Netherlands reaches a score of 95/100 concerning the openness and availability. In 2015, most of the open datasets on data.overheid.nl are geo-data (Fig. 26), and the main contributors can be seen in Fig. 25.

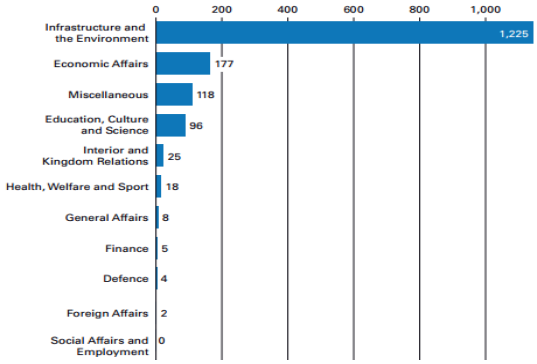

Figure 39: Datasets on data.overheid.nl (source: Open Data Trend Report, 2015)

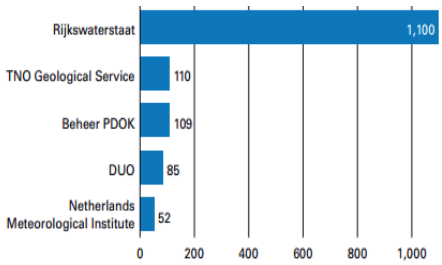

Figure 40 Top 5 contributors to data.overheid.nl (source: Open Data Trend Report, 2015)

6.5 Technology

The Dutch NSDI is based on open source technologies. For the web infrastructure, Geo server and Geo webcache is used. Mainly Postrgess is used on the geodatabase side. The National Georegister metadata portal is developed mainly on Geonetwork. A community for developers is fostering collaborations in the implementation level. OGC services provide the data to the users such as:

ABBREVIATION	*Description*	*Type*
WMS	Web Map Service	Raster Data (pictures)
WMTS	Web Map Tile Service	Raster Data (pictures)
TMS	Tile Map Service	Raster Data (pictures)
WFS	Web Feature Service	Vector Data (lines, points, etc.)
OpenLS	Location Service	geocode service
WCS	Web Coverage Service	coverage

PDOK is providing the data via data services and data downloads. A list of all PDOK available services can be found under https://www.pdok.nl/nl/producten/pdok-services/overzicht-urls.

PDOK ArcGIS extension

For increasing the cross platform interoperability an ESRI Arcgis service for connecting ESRI products to PDOK portal has been developed (https://www.pdok.nl/nl/producten/pdok-software/pdok-extensie-voor-arcgis). This extension has been developed as open source and the source code is available on Github (https://github.com/esrinederland/pdok-extensie, last).

PDOK QGis plugin

A QGIS plugin facilitates the easy retrieval of INSPIRE data and metadata from the National Georegister INSPIRE datasets (https://www.pdok.nl/nl/inspire-qgis-plugin).

The PDOK Kaart

PDOK Kaart is a Map API for integrating maps into websites. It can be used by everyone, both for public websites and commercial and private websites and blogs. The use of PDOK Kaart is free.

Linked Open Data Nederland Platform

Following technological advances, the open linked data approaches are introduced to the public sector. The "Linked Open Data Nederland" platform is the first work by Geonovum to providing linked information.

National Georegister API

The metadata from the National Georegistrer can be accessed by a CSW Api. This metadata can be used in other portals and applications.

Both CSW 's are available:

- http://nationaalgeoregister.nl/geonetwork/srv/dut/csw?
- http://nationaalgeoregister.nl/geonetwork/srv/dut/inspire?

Coordinate Transformation Service

A coordinate transformation service is provided by Geonovum and is particularly important in the scope of INSPIRE when data has to be translated from the National Triangulation System (RD) to ETRS89.

GeoSticker Metadata Editor

In order to facilitate the attachment of metadata to geodata and webservices that are implemented with ArcGIS products, ESRI Netherlands has developed the easy to use Metadata Editor (Fig. 27). It is accepted and used within various provinces, ministries and other organizations that are already using ArcGIS software.

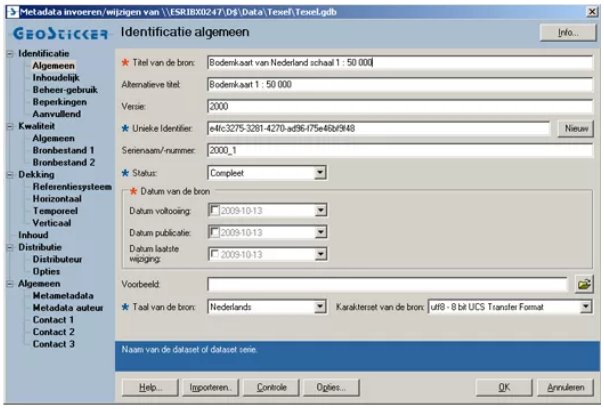

Figure 48: GeoSticker user interface (source: http://sensorsandsystems.com/key-elements-of-the-dutch-nsdi/)

7. Maturity Level Assessment and Reasons

7.1 Organizational

Around 2000, the Netherlands reached level 2 in the Maturity Model. With the Dutch National Clearing House (NCGI), a first version of complete organization and coordination activities had already been introduced since 1995 (section 3.1.1). It can be considered as one of the first projects to receive governmental funds for a whole organization initiative. Key-registers were first introduced in 2000 and were the first authoritative datasets to have defined custodianships (section 3.3.1). Examples of sporadic data sharing are the Dataland project (section 3.5.4), cross boarder SDI with NRW (section 3.5.6) and the cooperation project in the Veluwe region (section 3.5.5). Cooperations between public and private sector existed since 2000 i.e. between the Cadastre and the Notaries (section 3.5.1).

In 2008, the GIDEON strategy (section 4.5.1) was the driving force for reaching Level 3 and 4. It had a well-defined organizational structure, implementation and investment plan. The legal framework as well as the responsible authorities for the Key-registers were formally set.

Currently (2017), the Netherlands, has reached level 4 to 5 in the Maturity Model. The PDOK portal (section 6.4.1) and the National Georegister web catalogue (section 6.4.5) enable consistent and mature data sharing most of which adhere to the eGovernment and open data policies. The benefits of the NSDI are measured i.e. INSPIRE study and the study of the value of the geoinformation sector. An overview of the maturity level assessment is provided in Table 8.

7.2 Data

Around 2000, the Netherlands reached level 2 in the Maturity Model. Data arrangements were made for sharing geodata i.e. Dataland project (section 3.5.4), cross boarder NSDI with North Rhine Westphalia (section 3.5.6). Since 1996, the Idefix standard have been developed for publishing metadata and OGC standards have been in use for services and metadata (section 3.1.1).

Foundation data themes were defined in 2000 with the introduction of Key-registers (section 3.3.1). With the implementation of the PDOK portal (2008-2012) as a single point of truth dataset and the establishment of open data policies (Strategic Vision on Open Data) and Dutch open government data portal (https://data.overheid.nl/) in 2011, level 3 was reached (section 6.4.5).

Nowadays, level 4 to 5 in the Maturity Model is reached. Data and metadata is provided via a centralized architecture (PDOK, National Georegistry) (section 6.4.1, 6.4.5). Open data policies are implemented (Open Data Action Plan) (section 6.4.6) and the increase of hits in the PDOK portal proves the growing use of spatial data (section 6.4.1). An overview of the maturity level assessment is provided in Table 9.

7.3 Standards

Netherlands has a long tradition in using standards. Around 1996, the Netherlands had reached level 2 to 3 in the Maturity Model. In the NCGI program, standards were used and e-services were exploited. In 1996, the Idefix national geodata standard was implemented (section 3.1.1).

In 2017, the Netherlands has reached level 5 in the Maturity Model. Since 2005, a complete framework for standards has been in use (section 4.6). Since 2009, the Director of Geonovum participates in the OGC Board of Directors. Open standards and service oriented architectures are widely used. An overview of the maturity level assessment is provided in Table 10.

7.4 Technology

Around 1995, the Netherlands reached level 2 in the Maturity Model. In the NCGI program the transition from geographic information systems to portal architecture was initiated enabling limited system interoperability and compliant spatial data services (section 3.1.1)..

In 2008 with the realization of the GIDEON strategy, an organizational spatial data architecture was implemented (section 4.5.1).

In 2017, the Netherlands has reached level 4 to 5 in the Maturity Model. Since 2007, within GIDEON and NORA, spatial data services with defined SLAs have been implemented. A flexible spatial data architecture that allows scalability and constant improvements is realized with the use of open source technologies (section 6.5). An overview of the maturity level assessment is provided in Table 11.

7.5 People

In 2007, level 3 to 4 in the Maturity Model was reached. The RGI can be considered as the first coordination with education facilities (section 3.4). Coordinated whole of organization user needs analysis was made within the SDI for crisis management project (2006) (section

4). In GIDEON, a formalized communication plan and cooperative culture were realized (2007) (section 4.5.1).

Nowadays, level 4 to 5 has been reached. User feedback is captured in several cases i.e., in the PDOK forum, the Feedback Mechanism of the Topography Register (section 6.3.4), while mature user engagement appears in many crowdsourcing activities i.e., the "Making Sense for Society Platform" (section 6.3.5). An overview of the maturity level assessment is provided in Table 12.

As can be seen in Fig. 28, in the beginning the Dutch NSDI had a repeatable form and was at Maturity Level 2 in approximately all components (data, standards, organizational and technology). Nowadays, it has reached Maturity Level 4 to 5.

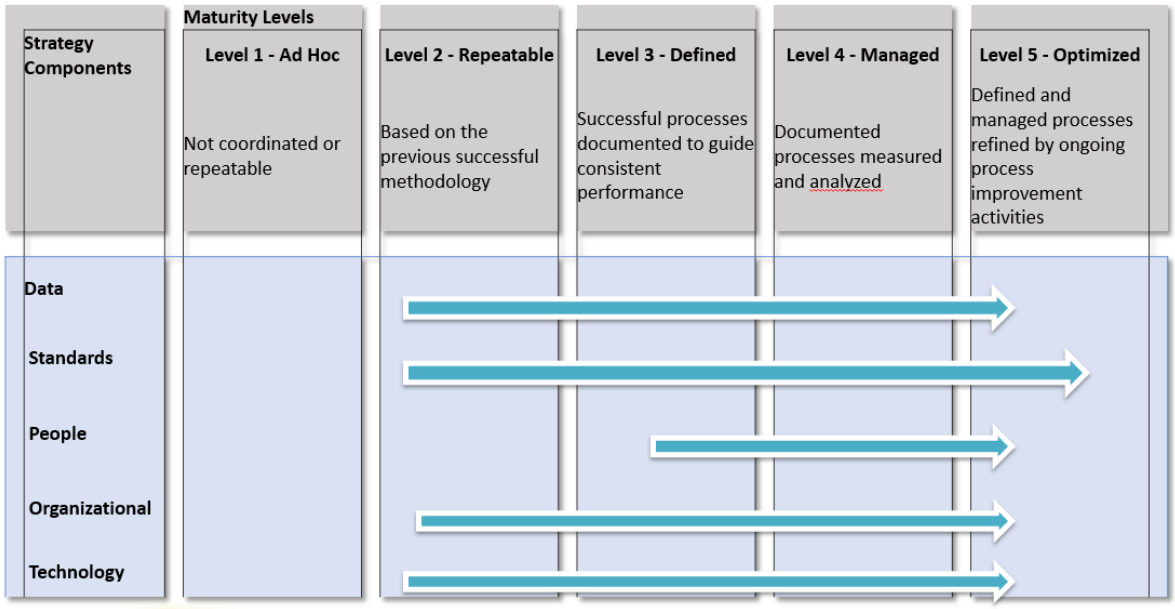

Figure 56: Maturity Level Assessment for the Dutch NSDI

Table 8: Organizational Maturity Level Assessment

ORGANIZATIONAL								
LEVEL 1 - Ad Hoc		**Level 2 - Repeatable**		**Level 3 - Defined**		**Level 4 - Managed**		**Level 5 - Optimized**	
No cross-organizational governance framework in place		Initial whole of organization coordination activities	1995	Whole of organization governance structures established	2008	Mandate and legal frameworks in place	2008	Ongoing monitoring and continuous improvement	
No standard operating procedures (SOPs) identified, compliance and tracking not consistent		Custodianships and stewardship principles defined	2000	SOPs consistently tracked and verified		Formal custodianship and stewardship roles defined	2008	Measuring ROI and benefits realization	2010
Project by project funding		Some SOPs documented		Defined strategy and Implementation Plan	2008	Strategy implemented, KPIs monitored		Data sharing is consistent, mature and successful	2017
Case by case partnerships		Some whole of organization funded initiatives	1995	Whole of Organization investment plan	2008	Business case driven investments			
No market coordination or focus		Sporadic data sharing	2001	Public / Private Partnerships	2000	Operational budget allocations			
No successful initiative in data sharing				Inconsistent Data sharing with elements of success	2000	Data sharing in place but still immature			

Table 9: Assessment of the Maturity Level of the Data Component

DATA								
LEVEL 1 - Ad Hoc		**Level 2 - Repeatable**		**Level 3 - Defined**		**Level 4 - Managed**		**Level 5 - Optimized**	
Internally focused data management		Emerging, peer to peer data sharing arrangements	2000	Single Point of truth principles	2007	Foundation Data published, shared and maintained	2011	Ongoing monitoring and continuous improvement	2017
Data duplication		Some (meta)data publications	1996	Foundation Data Themes defined	2000	All data published with compliant metadata	2005	Growing spatial data and open data usage throughout community	2017
Project by project data and metadata collection				Open Data policies established	2011	Open Data policies implemented	2013		

Table 10: Assessment of the Maturity Level of the Standards Component

STANDARDS								
LEVEL 1 - Ad Hoc		**Level 2 - Repeatable**		**Level 3 - Defined**		**Level 4 - Managed**		**Level 5 - Optimized**	
No common standards identified or implemented		Documented spatial data standards framework	1996	All (meta)data published in standards compliant formats, protocols and services	2005	Monitoring and expansion of standards compliance	2008	Proactive, contributing role in (international) standards, organizations ensure organizational needs are reflected in emerging standards	2009
		Selective standards adoption	1995	Observer role in (international) standards organizations	2009	Common data models defined for Foundation Data			
		e-enabled services not exploited		e-enabled services sporadically exploited	1995	Partial integration with other organization wide e-enabled service standards	2007	Fully integrated e-enabled services standard	

Table 11: Assessment of the Maturity Level of the Technology Component

TECHNOLOGY								
LEVEL 1 - Ad Hoc		**Level 2 - Repeatable**		**Level 3 - Defined**		**Level 4 - Managed**		**Level 5 - Optimized**	
Technology choices addressed on a project by project basis		Defined or organizational spatial data architecture		Organizational spatial data architecture being implemented	2008	Robust spatial data services with defined SLAa	2007	Spatial data architecture is flexible allowing for constant improvement and increased business efficiency	2017
No organizational spatial data architecture defined		Some elements of organizational spatial data architecture being implemented	1995	Compliant spatial data services	1995	Service monitoring		Business systems integration mature and effortless	
Case by case interoperability. Often vendor dependent		System specific interoperability		Vendor agnostic		Business systems routinely using spatial data services			

Table 12: Assessment of the Maturity Level of the People Component

PEOPLE									
LEVEL 1 - Ad Hoc		**Level 2 - Repeatable**		**Level 3 - Defined**		**Level 4 - Managed**		**Level 5 - Optimized**	
Diverse skills and resource availability		Defined skills and requirements		Defined skills and training requirements		Growing skills base		Ongoing monitoring and continuous improvement	
Ad hoc training and development		Informal knowledge sharing		Formal education and knowledge sharing resources		Coordination with education facilities	2004	Targeted sources and R&D activities	
No coordination communication		Case by case user needs analysis		Coordinated, whole of organization user needs analysis	2006	Regular user feedback captured		Mature user engagements	2017
Project by project user focus		Informal communication standards		Formalized communications plan	2008	Effective, coordinated communications		Pervasive awareness of spatial information benefits and availability	
No collaboration culture		Untrusted and sporadic collaboration culture		Cooperative culture	2008	Coalition and alliance culture		Strong collaboration and transparent partnership culture	

Information Sources

Inspiring the Netherlands implementation as a joint effort. https://inspire-forum.jrc.ec.europa.eu/mod/file/download.php? file_guid=1391, March 2009.

For unlimited opportunities with the knowledge of kadaster - kadaster annual review 2011 Licentie geo gedeeld - 1.0. https://www.rijkswaterstaat.nl/apps/geoservices/geodata/dmc/pdf-documenten/Geogedeeld-licentie-rijkswaterstaat.pdf, 2014

Public geo datasets at your service (pdok). https://www.epsa-projects.eu/index.php?title=Public_Geo_Datasets_at_your_Service_(PDOK 2017.

N.J. Bakker. Key registers as base for the dutch sdi. Kadaster, Apeldoor, Netherlands, June 2011.

Arnold Bregt. Space for geo-information: The next step? http://adaguc.knmi.nl/contents/documents/workshop2008/presentations/ADAGUC_WS2_20081205_Bregt.pdf, December 2008. ADAGUC Conference Amsterdam.

Arnold K Bregt and J Meerkerk. Space for geo-information: network for geo-innovation in the Netherlands. In *10th AGILE international conference on geographic information science*, 2007.

Lukasz Crompvoets Joep Castelein Watse T Bregt, Arnold K Grus and Jacqueline Meerkerk. Changing demands for spatial data infrastructure assessment: Experience from the netherlands. *A multi-view framework to assess spatial data infrastructures*, pages 357 - 370, 2008.

Wies Crompvoets Joep Bulens, Jandirk Vullings and Marcel Reuvers. The framework of standards for the dutch sdi. *Proceedings AGILE 2007*, 2007.

ECORYS Nederland BV and Grontmij Nederland BV. Cost-benefits analysis inspire - final report. Technical report, ECORYS Nederland BV and Grontmij Nederland BV http://www.geonovum.nl/sites/default/files/nkba_engelse_vertaling.pdf November 2009.

AK Castelein, Watse Tsjalling Bregt and Yvette Pluijmers. The economic value of the dutch geo-information sector. *International Journal of Spatial Data Infrastructures Research*, 5: 58-76, 2010.

Watse Castelein and Miguel Angel Manso Callejo. Monitoring of spatial data infrastructures, http://www.idee.es/resources/presentaciones/JIIDE10/ID402_Monitoring_of_Spatial_Data_Infrastructures.pdf , 2010.

Dick Laarakker Peter De Bree, Floris Eertink. Assessing the quality of collaboration in Netherlands sdi, https://www.fig.net/resources/proceedings/fig_proceedings/fig2008/papers/ts01a/ts01a_02_debree_etal_2732.pdf, 2008.

Marlies de Gunst and Peter van Oosterom, Network computers at the Dutch cadastre, http://www.ifp.uni-stuttgart.de/publications/phowo97/gunst.pdf, 1997

Hans van Eekelen. Imgeo, the Dutch standard for the exchange of large scale geography, Inspire Conference Edinburgh, http://inspire.ec.europa.eu/events/conferences/inspire_2011/presentations/99.pdf, 2011

Peter van de Grommert, NCGI, National Clearinghouse Geo-Information of the Netherlands *'From Clearinghouse to SDI'* http://redgeomatica.rediris.es/CURSO_IDE_2004-05/documentos/2.Datos_Espaciales/b3.-ClearinghouseHolanda.ppt, 2002

Caroline Groot. Presentation NSDI in the Netherlands. Workshop on SDI good practices, Athens, March 2017.

Michael Groth. Sdi and open data developments in the netherlands. Enlargement and Integration Workshop Belgrade https://ec.europa.eu/jrc/sites/jrcsh/files/Geonovum_GRothe_SDI_Open_Data_Netherlands.pdf, Novembet 2014.

S. Breght A. Grus, L. Wijngaarden and W. Castelein. Implementing inspire in the Netherlands. *Roczniki Geomatyki*, 7:47{56, 2009.

Watse Crompvoets Joep Overduin Theo van Loenen Bastiaan van Groenestijn Annemarie Rajabifard Abbas Grus, Lukasz Castelein and Arnold K Bregt. An assessment view to evaluate whether spatial data infrastructures meet their goals. *Computers, Environment and Urban Systems*, 35(3):217{229, 2011.

F. Heemskerk. No. 98 letter of economic affairs secretary (translated), https://zoek.officielebekendmakingen.nl/kst-26643-98.html , September 2007.

Bart Koppens. Abstract KLIC the Dutch one call system https://www.concawe.eu/wp-content/uploads/2017/01/s3-4_summary_klic_the_dutch_one_call_system-2014-01257-01-e.pdf , April 2014.

Ferjan Koebben Barend Kraak, Menno-Jan Ormeling and Trias Aditya. The potential of a national atlas as integral part of the spatial data infrastructure exemplified by the new Dutch national atlas. *SDI convergence*, page 9, 2014.

Dorus Kruse. Pdok (public services on the map) https://joinup.ec.europa.eu/node/158315 January 2011.

Ananya Narain. The global geospatial industry outlook tells the geospatial readiness index of the countries https://www.geospatialworld.net/article/global-geospatial-industry-outlook/?utm_medium=referral&utm_source=onesignal&utm_campaign=push-notifications March 2017.

PDOK portal https://www.pdok.nl/

Stichting ICTU Programma OSOSS. Programme for open standards and open source software in government (ososs), 2004.

Sabine Put. Key elements of the Dutch NSDI http://sensorsandsystems.com/key-elements-of-the-dutch-nsdi/ May 2010.

Algemene Rekenkamer. Open data trend report 2015. Technical report, Algemene Rekenkamer, https://www.google.gr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&cad=rja&uact=8&ved=0ahUKEwjK5dOUh_TTAhUPOsAKHZNPARQQFggvMAE&url=http%3A%2F%2Fwww.courtofaudit.nl%2Fdsresource%3Fobjectid%3D23313%26type%3Dorg&usg=AFQjCNHOIFWj3SvvnwGkTHbAaLh6lM7VqA&sig2=F9X-ImvcL9B_ixOsO5l7dQ 2015.

Zakaria Goedertier Stijn Fernandez de Soria Ana Pignatelli Francesco Boguslawski Ray Stahlecker, Max Arrassi and Robin S. Smith. Descriptions of reusable location information solutions, 2017.

Jacob Ledoux Hugo Reuvers Marcel Klooster Rick Janssen Paul Penninga Friso Zlatanova Sisi Stoter, Jantien Beetz and Linda van den Brink. Implementation of a national 3d standard: Case of the Netherlands. In *Progress and New Trends in 3D Geoinformation Sciences*, pages 277{298. Springer, 2013.

Paul Van der Molen and Martin Wubbe. E-government and e-land administration-as an example: The Netherlands. In *6th FIG Regional Conference, San Jose, Costa Rica*, pages 12-15, 2007.

Haico van der Vegt. Pdok the public SDI of the Netherlands http://inspire.ec.europa.eu/events/conferences/inspire_2013/pdfs/26-06-2013_ROOM-4_14.00%20-%2015.30_119-Haico%20Van%20Der%20Vegt_Haico-Van-Der-Vegt.pdf 2013.

H Duizendstraal MB van Veller, MGP Fransen and W Gerritsma. Effect van "Ruimte voor geo-informatie" op giscience in nederland: eindrapport rgi-402. Technical report, Bibliotheek Wageningen UR, 2009.

Danny Vanderbroucke and Dimitrios Biliouris. Spatial data infrastructures in the Netherlands: State of the play 2011. Technical report, K.U.Leuven (SADL and ICRI) http://inspire.ec.europa.eu/reports/stateofplay2011/rcr11NLv123.pdf, 2011.

Gideon-key geo-information facility for the Netherlands. Technical report, VROM http://www.geonovum.nl/sites/default/files/GIDEON2008-2011_Engels.pdf 2008.

Geonovum VROM. Inspire member state report: Netherlands, 2009. Technical Report April, https://www.google.gr/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjBmMD9h_TTAhVrJMAKHSf6CgIQFgghMAA&url=http%3A%2F%2Finspire.ec.europa.eu%2Freports%2Fcountry_reports_mr%2FNL-Bijlage1-RapportagelidstaatNederland2009EUmadeENtranslation-final.doc&usg=AFQjCNGHfGnot8e77HMkoAyHo1uekmzwxw&sig2=wBKjlXdZtRvI9XYB_Suvtw , 2010.

APPENDIX I

Dutch and European legislation related to geoinformation

Dutch Legislation

- Amending the Copyright Act 1912, etc. (implementing Directive copyright and related rights in the information society)
- Public Records
- Copyright
- Databases
- Law for the protection of personal information
- Act of May 10, 2012 to amend the Telecommunications Act to implement the revised telecommunication directives

Basic Registrations

- Wet key registers addresses and buildings
- Wet basic registration scale topography
- Wet basic registries cadastre and topography
- Property Valuation Act

Re-use of Public Sector - open data

- Law reuse of public sector information (including July 18, 2015)
- Parliamentary legislative proposal open government (Woo)
- Open Government Act
- Law implementing the Aarhus Convention

INSPIRE - environment

- Dutch implementing the EC Directive spatial data infrastructure
- decision INSPIRE
- Laws of environmental Conservation
- European and international> INSPIRE | environment
- Dutch INSPIRE program

Surface - Cables and pipes

- Law Information Exchange underground networks

Planning - surroundings

- General Administrative Law Act
- Spatial Planning Decree
- Crisis and Recovery
- environmental code
- Regulations Standards Planning 2012
    - Modification of the scheme: new version of the external appearance of buildings STRI2012 digital photos
    - Modification of the scheme: new version of the SVBP2012 related concepts and methods of measurement
- Regulations Standards Planning 2008
    - Amendments to the legislation: RO 2008 Standards, Version 1.1 standards
    - Modification of the scheme: effective date January 1, 2010
    - Modification of the scheme: WRO instruments to Wabo and link environmental permit with RO 2008 Standards
    - Modification of the scheme: new version of the SVBP2008 concerning the Wabo
- Law General Provisions Environmental Law
- Spatial Planning Act

Water

- Decision quality and water monitoring in 2009
- Decision establishing monitoring WFD
- shipping Traffic

Wealth

- Housing

European and international legislation

General - Intellectual property

- Directive 96/9 / EC of the European Parliament and the Council of 11 March 1996 on the legal protection of databases

- Directive 2001/29 / EC of the European Parliament and of the Council of 22 May 2001 on the harmonization of certain aspects of copyright and related rights in the information society

Data protection

- Data file Reform Commission
- Directive 95/46 / EC of the European Parliament and the Council of 24 October 1995 on the protection of individuals with regard to the processing of personal data and on the free movement of such data
- Directive 2002/58 / EC of the European Parliament and of the Council of 12 July 2002 concerning the processing of personal data and the protection of privacy in the electronic communications sector (Directive on privacy and electronic communications) (e-Privacy Directive)
- Amendment ePrivacy Directive
- Article 29 Working Party Opinion 8/2014 on the Recent Developments on the Internet of Things
- Article 29 Working Party Opinion 06/2013 on open data and public sector information (PSI) reuse
- Article 29 Working Party Opinion 03/2013 on purpose limitation
- Article 29 Working Party Opinion 13/2011 on geolocation services on smart mobile devices
- Article 29 Working Party Opinion Nº 4/2007 on the concept of personal data - WP 136
- EDPS ' Opinion of the European Data Protection Supervisor on the "Open-Data Package" of the European Commission-including a Proposal for a Directive amending Directive 2003/98 / EC on re-use of public sector information (PSI) [. .] "

Re government - open data

- Digital Agenda for Europe
- See also: Website Digital Agenda for Europe | open Data
- Commission Notic E (2014 / C 240/01) "Guidelines on recommended standard licenses, datasets and charging for the re-use of documents'
- Directive 2013/37 / EU of June 26, 2013 amending Directive 2003/98 / EC on re-use of public sector
- Directive 2003/98 / EC of 17 November 2003 on the reuse of public

INSPIRE - environment

- Directive 2007/2 / EC of 14 March 2007 establishing an Infrastructure for Spatial Information in Europe (INSPIRE)
- Directive 2003/4 / EC of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313 / EEC
- Implementing Data Specifications
- Implementing Parts of geo-data and services
- implementing Metadata
- Implementing Monitoring and Reporting
- implementing Network

Water

- Directive 2000/60 / EC of 23 October 2000 establishing a framework for Community action on water policy
- Directive 2005/44 / EC of 7 September 2005 on harmonized river information services (RIS) on inland waterways in the Community

APPENDIX II

Standards in the Dutch geoinformation landscape

3D geoinformation

OpenGIS® CityGML Version 2.0

Basic model NEN3610

Basic model geo-information (NEN3610: 2011)

Management public space

Information Model Management Public Space (IMBOR)

Mapping: IMGeo and BS 2767-4 Condition Metering Infrastructure

Mapping: Dutch CAD standard and IMGeo

BGT - IMGeo

Message Traffic Message Schedule StUF Geo BAG Version 1.0

Message Traffic Message Schedule StUF Geo IMGeo version 1.1.1

Message Traffic Message Schedule StUF Geo IMGeo version 1.2 - Message Catalog

Message Traffic Message Schedule StUF Geo IMGeo version 1.2 - BGT

Message Traffic Message Schedule StUF Geo IMGeo version 1.3 - Message Catalog

Message Traffic Message Schedule StUF Geo IMGeo version 1.3 - Geo-BOR

Messaging Domain Value Lists GML / StUF Geo IMGeo version 2.1

Messaging IMGeo - Guideline Version 1.1.1

Messaging StUF Geo BAG - WSDL

Messaging StUF Geo BAG: BAG Geo-Messaging v1.0

Messaging StUF Geo IMGeo v1.1.1 - BGT Messaging v1.0 - WSDL

Messaging StUF Geo IMGeo v1.2 - BGT Messaging v1.0 - WSDL

Messaging StUF Geo IMGeo v1.3 - WSDL - Geo-BOR

Messaging StUF Geo IMGeo: BGT Messaging v1.0

Messaging StUF IMGeo Geo Geo-BOR messaging v1.1

Data Catalog BGT 1.1.1

Data Catalog IMGeo version 2.1.1

IMGeo simple XSD (GML light)

IMGeo-2.1.1.xsd

Information Model Management Public Space (IMBOR)

Executive Summary BGT | IMGeo

Mapping: IMGeo and BS 2767-4 Condition Metering Infrastructure

Mapping: Dutch CAD standard and IMGeo

Objects Manual BGT | IMGeo version 1.1

Visualization BGT | IMGeo guide version 2.0 - with attachments

Visualization Symbol BGT | IMGeo version 2.0

Soil and Substrate

Information Model Key Register Substrate (Imbro)

Measurements Information Model (IM measurements)

Soil and Archeology

Archeology Information Model (IM SIKB0102)

Soil Information Model (IMSIKB0101)

Measurements Information Model (IM measurements)

Terms of Use

Creative Commons Zero (CC0)

Geo Shared

Public Domain Mark

Geography Markup Language (GML)

OpenGIS® CityGML Version 2.0

OpenGIS® GML 3.1.1

OpenGIS® GML 3.2.1 Encoding Standard

OpenGIS® GML 3.3 Encoding Standard

OpenGIS® GML Simple Features Profile

INSPIRE

INSPIRE Data Specifications

INSPIRE Feature Concept Dictionary

INSPIRE Generic Conceptual Model

INSPIRE glossary

INSPIRE Guidelines for the encoding of spatial data

INSPIRE Methodology for the development of data specifications

INSPIRE Specification Coordinate Systems

INSPIRE Specification Geographical Grid Systems

Technical Guidance INSPIRE Discovery Services

INSPIRE Technical Implementation Guidance Download Services

INSPIRE Implementation Technical Guidance View Services

INSPIRE Technical Guidelines on EN ISO 19115 and EN ISO 19119

Cables and pipes

Information Model Cables and Pipelines (IMKL)

Cadastral parcels

Land Registry Information Model (IMKAD)

Linked open data

GeoSPARQL

Resource Description Framework

SPARQL

Metadata

INSPIRE Technical Guidelines on EN ISO 19115 and EN ISO 19119

Dutch metadata profile on ISO 19115 geography, 1.3

Dutch metadata profile on ISO 19115 Geography, 1.3.1

Dutch metadata profile on ISO 19119 Services 1.2

Dutch metadata profile on ISO 19119 services 1.2.1

Measurements and Observations

Measurements Information Model (IM measurements)

OGC Sensor API Things Part 1: Sensing

OpenGIS® Observations and Measurements

Nature

Information Model AERIUS (IMAER)

Information Model Nature Management Plans (Imnah)

Public order and safety

Information Model messaging Digital Access Card

Information Model IMOOV conceptual model version 1.1

Information Model IMOOV UML model version 1.1

Visualization IMOOV Cartography Standards

Visualization IMOOV symbols with descriptions Overview

Visualization Symbol IMOOV

Planning

Information Modeling Spatial Planning (IMRO2012)

Information Model Planning Plan Lyrics (IMROPT2012)

Practice Order in Council (PRAMvB2012)

Practice Analog Zoning Map (PRABPK2012)

Practice Zoning (PRBP2012)

Practice Area-Acts (PRGB2012)

Practice Plan Texts (PRPT2012)

Practice Provincial Regulation (PRPV2012)

Practice Structure Visions (PRSV2012)

Practice Accessibility Spatial Instruments (PRTRI2012)

Spatial Accessibility Standard Instruments (STRI2012)

Standard Similar Zoning (SVBP2012)

SVBP2012 Function List (Annex)

Sensors

Measurements Information Model (IM measurements)

OGC Sensor API Things Part 1: Sensing

OpenGIS® Observations and Measurements

Sensor Observation Service (SOS)

Sensor Planning Service (SPS)

Services

Dutch metadata profile on ISO 19119 Services 1.2

Dutch metadata profile on ISO 19119 services 1.2.1

Dutch profile Web Map Service in ISO 19128 version 1.0

Dutch profile Web Map Service in ISO 19128 version 1.1

Dutch WFS section 1.0.1 of ISO 19142 for Web Feature Services 2.0

Dutch WFS section 1.1 ISO 19142 for Web Feature Services 2.0

OpenGIS Web Map Service (WMS) Implementation Specification 1.3.0

OpenGIS® Catalog Service Implementation Specification 2.0.2

OpenGIS® georeferenced Table Joining Service Standard Implementation 1.0

OpenGIS® Web Feature Service Interface Standard 2.0 (also ISO 19142)

OpenGIS® Web Feature Service Implementation Specification 1.1

OpenGIS® Web Map Tile Service Standard Implementation

Clinical practice Tiling 1.1

Sensor Observation Service (SOS)

Sensor Planning Service (SPS)

Topography

Information Model TOP10NL

Visualization

Guidance Webcartografie Part 1

Guidance Webcartografie part 2

Guidance Webcartografie part 3

OGC Web Services Context Document

Styled Layer Descriptor profile of the Web Map Service Implementation Specification 1.1.0

Symbology Encoding Implementation Specification 1.1.0

Visualization BGT | IMGeo guide version 2.0 - with attachments

Visualization IMOOV Cartography Standards

Visualization IMOOV symbols with descriptions Overview

Visualization Symbol IMOOV

Web Guidelines and geo 2.0 beta

Water

Measurements Information Model (IM measurements)

Information Model Municipal Water (IMSW)

Information Model Water (IMWA)

APPENDIX III

Validators for geodata and services

Generic validators

- GML 3D geometry
- GML 3.x 2D geometry
- GML3.2 Simple Features

Generic conformance tests

- Protocol conformance test standards
- NEN 3610 (draft)
- GML data

BGT IMGeo validators

- IMGeo GML
- StUF Geo IMGeo Vertical interface
- StUF Geo IMGeo Horizontal interface

Spatial planning validator

- RO Standards

INSPIRE validators

- INSPIRE GML Schema validation by theme
- INSPIRE View and Download Services
- INSPIRE Discovery Services

Conformance Tests for INSPIRE

- INSPIRE Discovery Service
- INSPIRE Download Service
- INSPIRE View Service

Service validators

- Web Feature Service
- Web Map Service

Conformance Tests for Web Services

- Dutch profile on ISO 19128 Geographic Information Web Map Server

- Dutch profile on ISO 19142 Geographic information - Web Feature Service (WFS 2.0)

Metadata validators

- Dutch metadata profile on ISO 19115
- Dutch metadata profile on ISO 19115 plus INSPIRE
- Dutch metadata profile on ISO 19115 plus INSPIRE harmonized
- Dutch metadata profile on ISO 19119
- Dutch metadata profile on ISO 19119 plus INSPIRE

Conformance Tests for metadata

- INSPIRE metadata profile on ISO 19115 for geography
- INSPIRE metadata profile on ISO 19119 for services