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Dike Data Management in Flanders

Gestion de la sûreté des digues en Flandre

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ABSTRACT: Belgium has around 700 km of (large) dikes, protecting the hinterland from tidal and river flooding. Although there's a lot of information/data regarding these dikes available (coming from monitoring campaigns, surveys,…), it's not easy to collect and process all this data in a uniform way. In Flanders, steps have been made to enhance the data management so the dike managers can perform their management in a most efficient way. Since 2015, a knowledge center on dikes and embankments is established. This network consists of a co-operation between all the dike managers and the supporting technical divisions (regarding for example geotechnical and hydraulic topics) of the Flemish Government. The main goal of this co-operation is the further professionalisation of the dike management, which involves also the data management. Sharing all the relevant information between the different stakeholders in a uniform and digital way is a big part of this. Recent developments focus on collecting all the relevant data/information in GIS-oriented webapplications, which can be easily consulted by all stakeholders. Through these webapplications coupling is made between the different databases. Also new functionalities are programmed and reporting and analyses of the data is facilitated and enlarged. Hereby maintenance, surveys and constructing of dikes and embankments can be performed in a most efficient way.

RÉSUMÉ: En Belgique environs 700km de digues protègent l'arrière-pays contre des inondations liées aux rivières et aux grandes marées. Bien que beaucoup d'information et de données sont disponibles concernant ces digues (issus de campagnes de surveillance, inspections ...) il s'avère pas facile de recueillir et traiter toutes ces données d'une manière uniforme. En Flandre des mesures ont été prises pour améliorer la collecte de données afin de permettre une gestion efficace de la sûreté des digues par les responsables. Depuis 2015 un centre de connaissance pour digues et berges a été créé. Ce centre origine d'une coopération entre tous les gestionnaires des digues et les divisions d'appui technique (concernant entre autres des problèmes géotechniques et hydrauliques) de la Communauté Flamande. L' objectif principal de cette coopération est la poursuite de la professionnalisation de la gestion des digues, comprenant aussi la collecte de données. Un grand défi consiste à réaliser un échange d'informations pertinentes par voie numérique et uniforme entres les différents acteurs. Les évolutions récentes sont axées sur la collecte de toutes données pertinentes dans des applications web SIG orientées, facilement accessibles pour tous les acteurs. En réalisant ces applications web les différentes bases de données sont mises en correspondance. De nouvelles fonctionnalités sont programmées, et l'analyse et la notification de données sont facilitées et élargies. De cette façon la construction, l'entretien et l'inspection de digues et berges peuvent être réalisées d'une manière plus efficace.

Keywords: data management, dikes, embankments, GIS, webservices

1 INTRODUCTION

Belgium has around 700 km of (large) dikes, protecting the hinterland from tidal and river flooding. Regarding flood protections three types of waterways can be distinguished: the coastline and the navigable waterways (see Figure 1) and the (smaller) non-navigable waterways. The management of both dikes and embankments along these waterways is divided over different divisions within the Flemish Government (the dike managers). Supplementary, some technical divisions regarding for instance geotechnical and hydraulic topics are supporting the dike managers.

Figure 1. The navigable waterways and coastline of Flanders, Belgium

There‘s a lot of information/data regarding these dikes available (coming from monitoring campaigns, surveys,…), but it is not easy to collect and process all this data in a uniform way that will give a good and complete overview of all the available information. In Flanders, steps have been taken to enhance the dike data management so the dike managers can perform their management in a more efficient way.

2 KNOWLEDGE NETWORK ON DIKES AND EMBANKMENTS

Since 2015, a Knowledge Network on Dikes and Embankments (abbreviation KND) is established see Figure 2. This network consists of a co-operation between the waterway management divisons (the dike managers) and the supporting technical divisions of the Flemish Government.

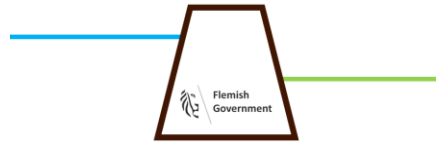

Figure 2. Flemish Knowledge Network on Dikes and Embankments (KND)

The main goal of this co-operation is the further professionalisation of the dike management in Flanders through a knowledge exchange network wherein communication and collaboration are the most important facets.

The different partners within the KND are The Flemish Waterway (dVW, navigable waterways), Flanders Environment Agency (VMM, non-navigable waterways), Agency of Maritime Services and Coast (MDK-aK, coastal area), the Geotechnical Division (GEO), Flanders Hydraulics Research (FHR, hydraulic division), Research Institute of Nature and Forest (INBO, ecological division) and Flanders Information Agency (AIV, technical support division).

Within this partnership, there is an agreement to work on the following topics: datamanagement, inspection and maintenance, monitoring techniques, stability reviews, design and construction.

Concerning the theme of the datamanagement, sharing all the relevant information between the different stakeholders in a uniform and digital way is the most important goal.

3 CURRENT SITUATION

As mentioned, there is a clear need for a more uniform and encompassing approach to dike datamanagement.

Currently, often data is stored in different separate databases or even in local folders. Frequently, there is no GIS-component. Because of this, relevant data gets sometimes lost or the different partners aren‘t aware of available important information. There is also not much communication between different databases.

When executing new monitoring campaigns, no agreements have been made about the most suitable datatypes and storage.

As visualised in Figure 3, there is a lot of information needed to perform an adequate dike management. Data needs to be collected regarding geometry, hydraulics, geotechnics, geo-hydraulics, protections and revetments.

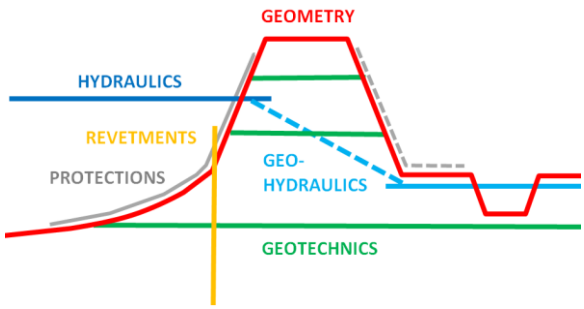

Figure 3. Types of information within dike management (Visser et al., 2015)

Furthermore, new data is gathered every time an inspection is performed or maintenance is executed. It is important to store this information in a way that it can be consulted by the different interested parties.

4 CURRENT (DIKE) MANAGEMENT APPLICATIONS

Figure 4 shows the current datatypes, databases and web applications within the Flemish Government. Below, some of the current available applications are discussed.

4.1 Available applications

4.1.1 Databank Ondergrond Vlaanderen (DOV)

Databank Ondergrond Vlaanderen (DOV) is the portal site of the Flemish government that contains all information about the Flemish subsoil in a GIS-environment: geotechnical data (CPT‘s and borings), geological information, groundwater data, soiltypes, ... DOV is free consultable and has a very user-friendly viewer. The data has passed a quality check before publishing on the database. Webservices are available to visualise this data in other tools.

4.1.2 Waterinfo

Waterinfo is the portal site of the Flemish government that contains all information about waterlevels, flooding, tidal data, rainfall and drought in a GIS-environment. Monitoring data as well as predictions are available. Maps, charts en graphs can be made and downloaded. Webservices are available to visualise this data in other tools.

4.1.3 Geopunt and BVK

Geopunt is the portal site of the Flemish government containing geographical data (digital height model Flanders, raw remote sensing data (whitin the Beeldverwerkingsketen (BVK), mobile mapping data, historical maps,...) in a GIS-environment. Webservices are available to visualise this data in other tools.

4.1.4 Tools dike managers

The storage and processing of dike related data from realisation, inspection and maintenance (f.e. inspection reports, as- built plans, bathymetry campaigns, maintenance works,...) happen nowadays in every division in a self established way with self developed tools. Unfortunately, the manner and the tools are different throughout the

different dike management divisions and little communication is provided.

4.2 Goals

One of the main goals of the KND is the further professionalisation of the dike data management. This doesn‘t mean that all dike related data should be stored in the same database, but rather that good agreements have to be made about the most suitable location of storage, processing and visualisation. Most appropiate, specific technical data is managed by the concerning technical divisions and coupling and communication through webservices is made between these specific databases.

In this a central role is seen for easy accessible and GIS-orientated web applications for four main topics within the dike data management: subsoil, hydraulics, elevation and asset management, see the collored blocks in Figure 4.

Besides the realisation of these new and more central web applications also first general agreements and engagements have been set about uniform data format, data storage, data processing and data visualisation for each of the databases and/ or data management topics.

5 APPLICATIONS IN DEVELOPMENT

To achieve a more professional data management, a lot of developments are ongoing over the last years.

5.1 Elevation App (BVK)- Proof of concept – location maps

The existing application for management of mobile mapping and remote sensing data, the Beeldverwerkingsketen (BVK), was further developed into a Proof of Concept (PoC) to work as a central database with an above lying web application for management of all elevation data within the dike- and embankment management. In this environment also online functionalities were developed for creating surface profiles (cross profiles and longitudinal sections) and difference maps (of selected monitoring campaigns) based on the data files in underlying database (see Figure 5).

An important set of altimetric data (based on Lidar data) in the BVK is the digital height model (=DHM), which covers the entire area of Flanders. Also bathymetrical data sets were added for a number of test locations.

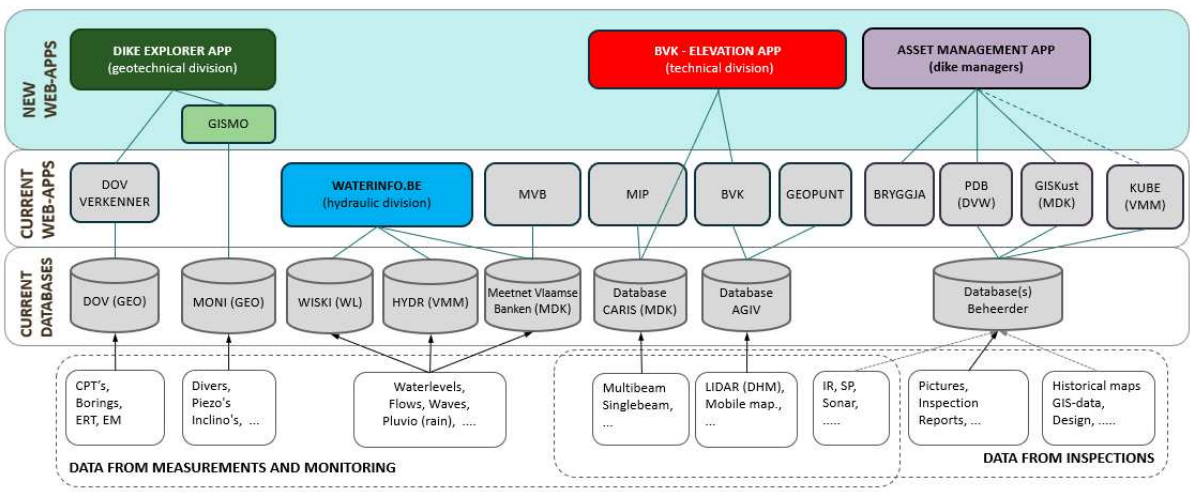

Figure 4. Overview of current and newly developed web applications within the Flemish dike data management

Besides the PoC for the web application also a PoC is performed to find out the extent to which the DHM can be used to derive the specific location of all the dikes and embankments in Flanders in order to draw up location maps. The added value of topographical measurements is investigated.

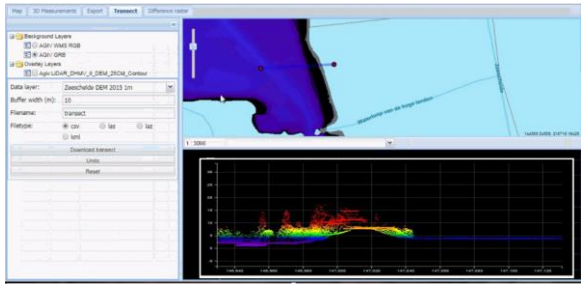

Figure 5. Newly developed Elevation Application (BVK) – Proof of Concept

The most important lessons learned from these PoC's are the following:

- A central web application for both altimetric and bathymetric data creates a very usefull and comprehesive platform for managing elevation data. In this way data can also be coupled easily to the other dike management applications.
- A central web application also creates opportunities to develop usefull and easy accesible functionalities for the every day work of dike management.
- To derive a location map of all dikes and embankments, smart algorithms aren't sufficient. Some manual modifications always remain necessary.
- It is very important that general metadata and file types of future monitoring campaigns are determined and agreed on so that the import in the BVK can run quasi automatically and all new data can be taken into account.
- To achieve a frequent use by all partners (stakeholders) it is important that the interface is user friendly and the data files and related products are easy to handle for a non GIS expert.

5.2 Gismo

Within the Geotechnical Division of the Flemish Government, a new application called Gismo is developed to store, process and visualize all geotechnical monitoring data. This goes from groundwater measurements to inclinometers and even fibre optics. Until recently, this monitoring data was stored in separate file shares so an easy exchange with other applications and with the different partners wasn't possible.

The new application Gismo fulfills these demands: selected people (from the partners) can obtain a user account to view the monitoring data from their specific project. Data can also be visualised in Dijkenverkenner (see next paragraph). Even more, real-time monitoring data is processed on the fly and the graph functionalities are multiple.

5.3 Dijkenverkenner

Dijkenverkenner (English: Dike Explorer) is built upon the technology of Databank Ondergrond Vlaanderen (DOV). A seperate portal site is developed so selected users (with specific login accounts) can consult all relevant dike information through one viewer: geotechnical testing data, geotechnical monitoring data (webservice with Gismo), geophysical tests (f.e. EM and ERT), hydraulic data (webservice with Waterinfo), vegetation maps, ... Figure 6 shows the user inferface.

Communication through webservices with the other databases and dike management applications is realised. Also coupling with the asset management tool of the waterway agencies (see section 5.4) is foreseen. The graph

functionalities are multiple and the data is real-time up to date.

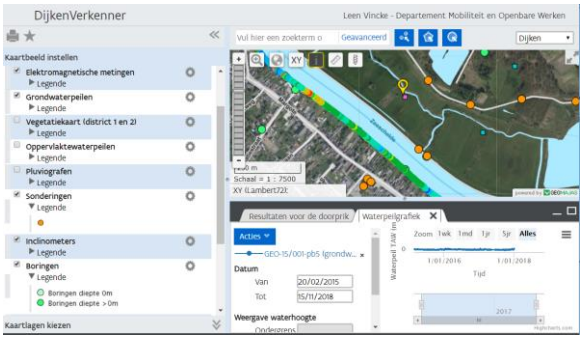

Figure 6. Dike Explorer

5.4 Asset management application

Currently in Flanders we are striving to use one centralised asset management tool to manage all types of data concerning all water-related infrastructures.

In preparation of the use of a joint application, it is very important to make the necessary agreements. Therefore, a co-operation structure was set up with various working groups. Every group handles a specific type of infrastructure, one off them is the group regarding the dikes and embankments, which is supported by the KND.

It‘s a very complex exercise to align the management of all kinds of assets (including dikes and embankments) between the different waterway agencies. Difficulties start already with the differences in used terminology.

At this moment, the definitions are fixed for all the objects that have to be maintained (the ′assets′). It is already concluded that a dike consists of several linear objects that run parallel to each other and that f.e. a sheet pile wall will be a different management object than the slope protection or the tow path. Obviously it must remain possible to implement collective maintenance and oversee the risk of failure for the total structure.

Following questions need to be adressed:

- Which dike related objects need to be distinguished?
- Which data needs to be collected for these objects?
- When does one object stop and does the next object start, both in the longitudinal and in the transverse direction?
- When is it necessary to make groups of objects (f.e collective measures)?
- How to get a total view of the overall quality/stability of the entire structure?

For the formalisation of these definitions an object type library (OTL) is created in which all agreements, completed within the working groups, are listed together. In this way, the similarities and differences between two types of objects quickly become clear.

Due to the continuous changes in the diverse patrimonies, this exercise will never be fully completed. The goal is to use this common asset management tool in early 2020 for the management of all dike- and embankment related assets in Flanders.

6 GOALS NEAR FUTURE

The BVK (Elevation App) will be developed further to an operational application that will be used to process all altimetric and bathymetric data (Multibeam, Lidar,..) and to make cross and longitudinal sections and difference maps. All new monitoring campaigns produce data in the same format and with fixed metadata.

As discussed in section 5.4, the development of one centralised asset management application to manage all types of data concerning all types of assets (including water-related infrastructures) is ongoing. In the near future, coupling will be made between the current available technical applications (f.e. Dijkenverkenner, Gismo, Waterinfo, BVK,...) and this new asset management application.

New functionalities will be programmed (f.e. inspection app/ module to be used in the field), and reporting and analyses of the data will be facilitated and enlarged.

This makes it possible to prioritize future monitoring campaigns, inspections and maintenance works. Hereby dike management can be performed in a more efficient way.

7 CONCLUSIONS

Dike management is distributed over different agencies in Flanders. A Knowledge Network on Dikes and embankments (KND) is established to enhance collaboration and communication between the different partners. Currently data management is one of the most important topics within the KND.

An overview is given of the data management applications that already exist and the (web) applications that are in development.

Main goal is to further professionalize the data management by coupling three supporting technical applications and underlying databases (geotechnical, hydraulical, geometrical, ...) with a centralised asset management application, developed in a collaboration of all Flemish waterway agencies.

In that way, dike management can be performed in a most efficient way and prioritizing of maintenance, inspections and monitoring campaigns can be elaborated.

8 ACKNOWLEDGEMENTS

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