Denmark's Elevation Model – Climate Challenges – Emergency Management – Be Prepared

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Have you ever lain awake at night wondering how the Danish Geodata Agency uses its own and others' geodata out there 'in the real life'? Have you pondered how Denmark's Elevation Model can be useful in emergency management when the forces of nature rage, when a gale blows, it rains and it is dark and cold? Have you sometimes asked yourself how one prepares to use geodata in a stressful situation, when your professional knowledge of geodata can contribute to making a difference as you collaborate with other competences? Have you ever heard about the rubber boot index? Will your mother-in-law be of any use when the police phones at midnight? Are there any answers to these questions?

Keywords: Emergency management, climate, spatial information, elevation data, elevation model

Introduction

When an extensive emergency management effort is required, the National Operative Staff (NOST) is called in. A permanent part of NOST at the Danish National Police is the Geo Staff, which contribute expert knowledge and advice on the use of geodata in a crisis situation. The Danish Geodata Agency (DGA) assists the National Police through the Geo Staff in NOST.

When the DGA assists the National Police in the use of geodata in a crisis situation, obviously, knowledge of – and access to – geodata is important. However, it is also important to know the conditions under which the advice will be needed. As any old boy scout would put it – *Be prepared!*

You may have access to any amount of geodata and any amount of programs for analysing data, but in a crisis situation, it is important to have done your homework in advance. Given some thought to which situations may arise, and how geodata can be of best use in a given situation – and be ready to put on your creative thinking cap.

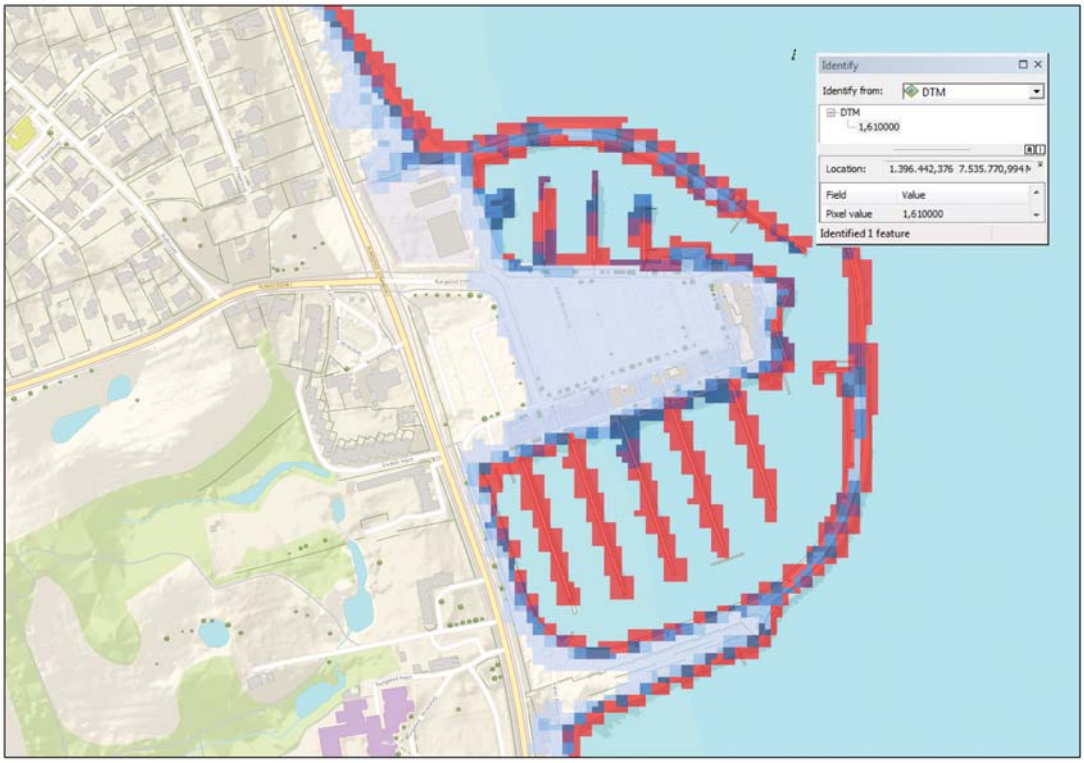


Figure 1. Elevation model information about the contour line of the harbour edge by Rungsted Harbour.

Denmark's Elevation Model has been used a couple of times in connection with crisis situations caused by the climate.

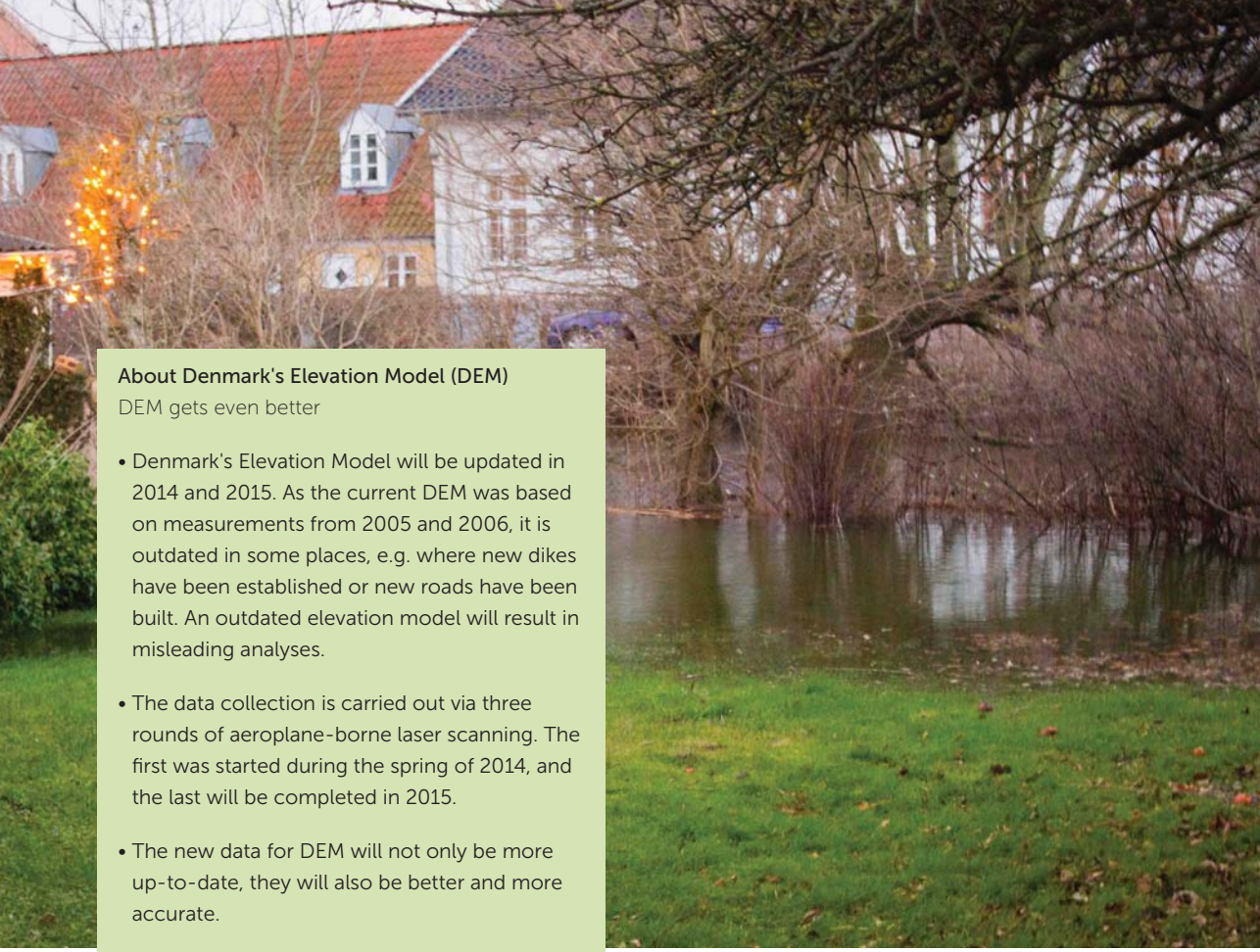
On a dark, cold and stormy November night...

The meteorologists had warned that a storm was heading towards Denmark and that there would be unusually high waters in the Sound. The local emergency staff at the police headquarters in Elsinore had been called in and wanted expert geo assistance. The question was which areas might be flooded by rising seawater from the Sound. This was important knowledge to have in order to be able to plan the emergency response.

A member of the Geo Staff at DGA received a phone call from the police around midnight. He had to scale a couple of fallen trees in his driveway in order to swap cars with his mother-in-law who had been summoned. He then went to pick up his colleague who happened to live close to the soon to be flooded Sound area.

During the night, and using the Elevation Model, maps were created that illustrated which areas along the Sound would probably be flooded in the course of the following morning. The Danish Meteorological Institute (DMI) and the Danish Coastal Authority (DCA) have some excellent services that show current and expected water levels at fixed locations in Denmark. This is very important knowledge to have when the Elevation Model is to be used to calculate which areas and which addresses are likely to be flooded.

However, more detailed information was needed than the fixed measuring stations that DMI and DCA were



About Denmark's Elevation Model (DEM)
DEM gets even better

- Denmark's Elevation Model will be updated in 2014 and 2015. As the current DEM was based on measurements from 2005 and 2006, it is outdated in some places, e.g. where new dikes have been established or new roads have been built. An outdated elevation model will result in misleading analyses.
- The data collection is carried out via three rounds of aeroplane-borne laser scanning. The first was started during the spring of 2014, and the last will be completed in 2015.
- The new data for DEM will not only be more up-to-date, they will also be better and more accurate.
- The point density in the new point cloud will be eight times higher than in the old one. This means that it is increased from approx. 0.5 points/m2 to approx. 4.5 points/m2.
- DEM will become more accurate, both in terms of plan accuracy, which will increase from approx. 70 cm to approx 15 cm, and in terms of elevation accuracy, which will increase from approx. 7 cm to 5 cm.
- DEM will be partly in colour. The colours for the individual points in the point cloud will be determined by means of concurrent photography (at all scans made during the day). The colours can be used to improve visualisation, among other things.
- The full waveform will be registered, and not the first and last pulse only, as is the case in the current DEM. Full waveform data is used in scientific studies of e.g. forests and forest floors.

able to provide. A police patrol reported that the water had now reached the edge of the quay in Rungsted Harbour. Using the Elevation Model, we were able to read the elevation for the exact area of the quay edge and thus supplement the measurements and the forecasts from DMI with updated knowledge from the effected area.

The storm Bodil was unusually long. The result was, among other things, that a huge amount of water was forced from the Kattegat into Issefjord and Roskilde Fjord.

Early Friday morning, an employee from the Danish Geodata Agency had to interrupt his usual journey towards the office at Rentemestervej and go to NOST in Ejby. The storm Bodil lasted unusually long and threatened to cause a storm surge along several stretches of coast.

Again, it was necessary to illustrate which areas would be hit by the storm surge, and again the Elevation

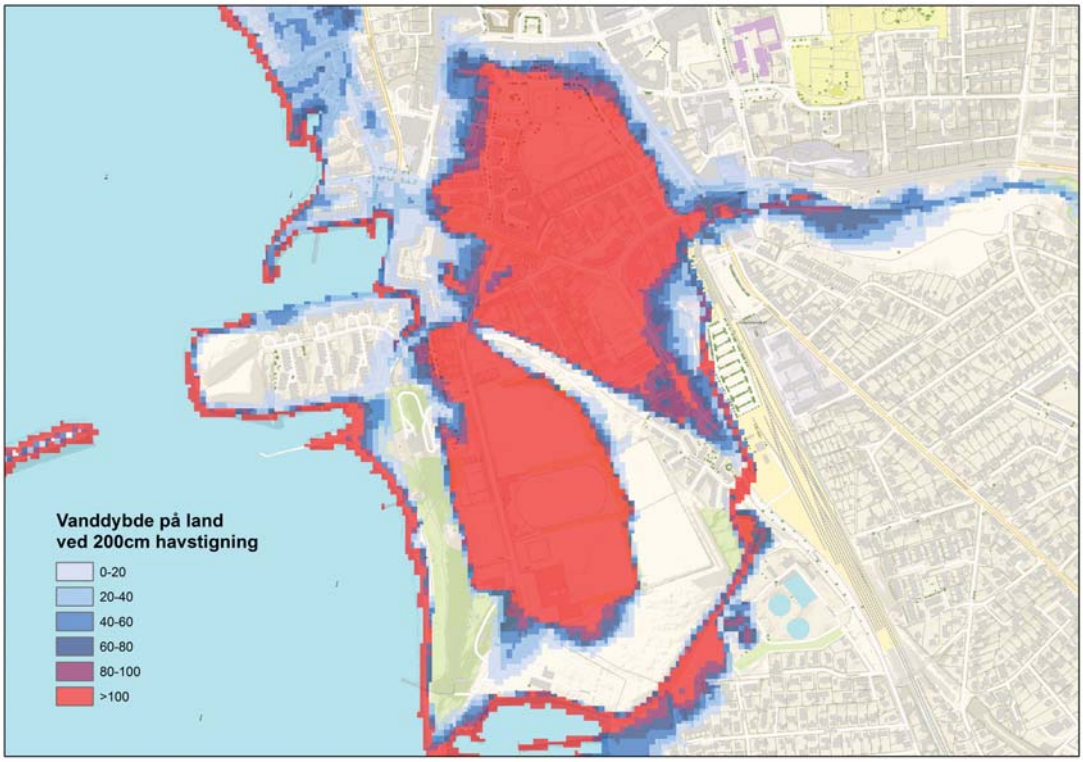


Figure 2. Selected areas that will be struck by the storm surge in the course of the day.

Model was used along with the measurements and forecasts from DMI and DCA.

In preparation for such situations, the Elevation Model had been converted into the *Rubber Boot Index*. This index may not be an international standard, but it provides an excellent illustration of where in a flooded area it is possible to wade through in rubber boots, where you can go through in a vehicle, and where you need to sail.

On Friday morning, when the storm Bodil threatened to cause a storm surge, it was possible, using forecasts from DMI, DCA, Denmark's Elevation Model and the Rubber Boot Index, to point out the areas that would be hit by the storm surge in the course of the day.

Now, what lessons can be learnt from this?

When you are under pressure, it is not enough to have access to a wealth of good and accurate data sources. It is important to have given some thought to how data are to be used.

Denmark's Elevation Model and flooding calculations can be downloaded as free data from the Danish Geodata Agency's website, and flooding calculations are accessible at Klimatilpasning.dk. They are excellent for planning and prevention when you have ample time. However – when the emergency authorities are to plan their response and assess, within a very short span of time, whether to send people from the emergency services to a given area, it is highly useful to have prepared your geodata so that you can quickly make an analysis that shows where you can walk in rubber boots and where you need to sail in a rubber boat.

In other words – Denmark's Elevation Model is worth gold – but, as the old boyscout said – Be prepared!