HMK – Swedish Handbook in Surveying and Mapping

Anders ALFREDSSON, Johan SUNNA and Clas-Göran PERSSON, Sweden

Key words: User guidelines, GNSS, Terrestrial surveying, Geodata capture

SUMMARY

The aim of the Swedish handbook in surveying and mapping is to contribute to an efficient and standardized handling of survey and mapping issues in Sweden. The objective is to provide guidelines and to support different user groups in the field of surveying and other types of geodata capture. Lantmäteriet, the Swedish mapping, cadastral and land registration authority, has a long tradition of supporting the Swedish surveying and mapping community. The same type of guidelines was written about 20 years ago and is widely spread within Sweden. New techniques and new working methods have increased the demands for an updated handbook. A common situation today is that a geodata capture project is ordered by procurement and then performed by some surveying company. The new working methods need a new structure of the supporting handbook, it needs to support both the procurement process and the actual geodata capture procedure.

The handbook covers most of the field of surveying and mapping and is now divided into two main parts, geodesy and geodata capture. The part of geodata capture includes several different sections, aerial photography, photogrammetric surveying, laser scanning, orthophoto and digital elevation models.

This presentation will however focus on the geodetic part. This part is divided into three sections. The first section is a knowledge base with information about the geodetic infrastructure in Sweden - such as reference systems and frames, map projections and geodetic surveying in general. The second section contains practical guidelines for different surveying techniques, such as GNSS and terrestrial techniques. For example, the GNSS section includes RTK, network RTK and static GNSS surveying. While the last section contain tables to help the reader to choose a suitable surveying method from the ones described in the second section. The main idea is that the geodetic part of the handbook would be possible to read both as an educational book, from top to bottom, and as support in procurement, from bottom and up.

The handbook is written mainly by Lantmäteriet in collaboration with the stakeholders and will be published in digital form continuously as the different parts are completed. The first completed documents were published in 2013 and the following documents will be published during 2014-2015. The handbook will in the future be updated with new versions to keep up with new demands.

HMK – Swedish Handbook in Surveying and Mapping

Anders ALFREDSSON, Johan SUNNA and Clas-Göran PERSSON, Sweden

1. INTRODUCTION

Lantmäteriet, the Swedish mapping, cadastral and land registration authority, has a long tradition of supporting the Swedish surveying and mapping community. In the mid-90s a set of nine handbooks was published covering different subjects such as geodesy, photogrammetry, cartography and digitizing.These books where widely spread within the mapping community in Sweden and some parts are still used today.When the old set of handbooks was published, the aim was to raise the awareness and the knowledge about surveying methods, and to reach out to the community in a standardized way. This was accomplished with very good results. Today, new techniques and new working methods have indeed increased the demands for an updated handbook.

To keep the recommendations updated with new techniques, several reports and publications have been published meanwhile during the years. Now it is time to gather all recommendations and toget an overall picture of the situation. In the writing of the new handbook several different information sources are used. Together with the older books, the recommendations will be based on our own investigations, reports and knowledge, but also reports and guidelines from other organizations and authorities around the world.

The new Swedish handbook in surveying and mapping is divided into two main parts, geodesy and geodata capturetogether with an introduction document. The introduction document will give an overview of the different documents in HMK and will serve as an introduction to the different parts, in addition there will also be a separate document describing the geodata quality. The two main parts arethen divided into several different sections as well. The part of geodata capture includes the following sections; aerial photography, photogrammetric surveying, laser scanning, orthophoto and digital elevation models. This paper will focus on the geodetic part of the handbook. As the geodetic part will provide the basic recommendations in geodetic surveying, the geodata capture part will use the geodetic part as reference for the related recommendations.

2. THE HANDBOOK

2.1 The aim of HMK

The handbook shall:

- Contribute to an efficient and standardized handling of survey and mapping issues in Sweden.
- Cover the needs for both a description of the Swedish geodetic infrastructure and actual surveying recommendations.
- Meet the demands from the surveying community in Sweden with recommendations on how geodetic surveying shall be performed and what parameters that shall be

reflected on.
- Be used for both educational purposes and in procurement processes.

To set the recommendations, various investigations in different fields will be needed. The investigations will result in a number of technical reports that will be the basis for the recommendations in the handbook.

2.2 GUM

The terminology toexpress uncertainties will follow GUM (Guide to the Expression of Uncertainty in Measurement). The GUM terminology isintroduced in the field of geodata capture and geodesy within the aim of HMK to give standardized recommendations and to raise the awareness of the community.

2.3 Digital Publishing of the Handbook

All parts of HMK will be published in digital format at a special website as pdf-files; no printed book will be made. By this the procedure to publish new versions of the documents will be simplified. All documents will be published on the website;www.lantmateriet.se/hmk. The first official documents in the geodata capture section where published in 2013, and in 2014 the plan is to publish the first parts of the geodetic section.

To keep the documents updated, the plan is to publish new versions of the documents once a year.

Together with the actual handbook, the technical reports mentioned in chapter 2.1 will be published at the website as well.

2.4 Time Plan

During 2014, the first versions of the geodetic part with the structure described in this paper will be published. First, the knowledge base and the GNSS section will be written, but the plan is to publish the section handling the terrestrial surveying in the end of the year as well.

The writing of the handbook will continue during 2015 to include also methods that are not handled in the first version. Then the handbook will be maintained with updated versions of the documents each year.

3. STRUCTURE OF THE GEODETIC PART OF THE HANDBOOK

The geodetic part of the handbook is divided into three sections, knowledge base, guidelines and a section to support the user to choose a suitable method. The idea is that the handbook should be possible to read in two directions.If the reader wants to have information for an educational purpose,the handbook should be read from top to bottom, but if used in a procurement procedure than it can be read from bottom and up. In the latter case the reader will be directed directly to the recommended parts in the guideline structure and not forced to

read the whole document to get the needed information.

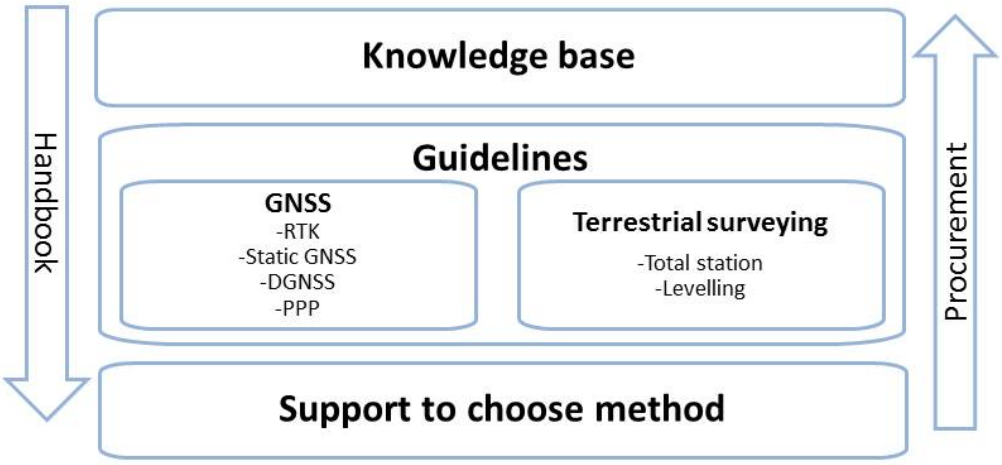

Figure 1: Structure of the geodetic part of the handbook

3.1 Knowledge Base

The knowledge base section will include information concerning the geodetic infrastructure in Sweden such asreference systems and frames, map projections and geodetic surveying in general.All recommendations will be based on the actual situation that are valid for the Swedish conditions, such as geoid model and map projections.Together with the recommendations,the handbook can be used in an educational purpose and provide a basic understanding for the national geodetic infrastructure. The reader can use the handbook to understand how to use the geodetic infrastructure in a proper manner.For example understanding how new points are established with respect to the reference benchmarks.

Nowadays when the GNSS techniques are common, a survey can be performed with respect to either active GNSS stations (e.g. networkRTK) or passive benchmarks. To get these different realizations of the reference system to be handled together, it is important to calculate the uncertaintyderived from different reference stations/benchmarks of the established points. The handbook will describe this procedure and include tables with expected uncertainties for benchmarks and services.

By reading the knowledge base for an educational purpose, the reader will get a common sense in geodetic surveying in general. By recommendations in basic geodetic handling, the handbook will help the user to make their own decisions.

3.2 Guidelines

The guideline section will be divided into at least two sections, GNSS and terrestrial techniques. The GNSS section is the first one to be published. It will consist of guidelines and recommendations for GNSS based surveying techniques and methods. In the first version, to be published during 2014, the guidelines will focus on the standalone surveying methods. Later it will be supplemented with combined methods such as GNSS integrated with

totalstation.

One of the key issues in the handbook is the need ofdescribing control methodsfor geodetic surveying.The control procedures will be described in a separate chapter and connected with links from each survey method.Methods to control network RTK measurementshave been investigated previously (Odolinski 2010b), and will be included and re-computed for shorter in-between-station distances (e.g. 35 km).

3.2.1 GNSS

The guidelines for the GNSS methods are the first section to be published. Initially, the GNSS section will include guidelines for static GNSS, RTK and network-RTK. Later on guidelines for Virtual RINEX, DGNSS and Precise Point Positioning (PPP)will be includedas well.

All techniques can be used in different ways, with different observation times for instance.Depending on how the techniques are used, several different levels of expected uncertainty can be distinguished. The guidelines will take this fact into account and describe up to five different levels foreach technique. The different levels will be designed so that significant differences for expected uncertainty will be distinguished. The different levels will contain recommendations on how the technique may be used as well as the degree of measurement details (e.g. PDOP) to be included in the survey report.

To be able to give specific recommendations in the guidelines and set the parameters for the different levels of expected uncertainty, some additional investigations are needed. In the RTK chapter for example we will study how the temporalcorrelation between observation sessions affects the measurement uncertainty.

Since the last edition of HMK, the processing of static GNSS has developed, we need to investigate the validity of our recommendations and in some cases also decide what our recommendations shall be. For instance no official recommendations on how to use the ionosphere-free combination (L3) exist.

3.2.2 Terrestrial surveying

Most of the recommendations from the previous edition of HMK are still valid in the area of terrestrial surveying. The work with this section is mainly to update and adjust the recommendations to the situation that are present today.

3.3 Support to Choose Method

If the reader wants to use the handbook in a procurement procedure this is the first document that the reader will enter. The idea is that the reader will get support to choose an appropriate surveying method based on the tolerance requirements and the actual conditions at the survey site. The expected uncertainty together with basic parameters affecting the survey will support the user to choose both an appropriate surveying technique and to set the levelof that technique.The document will be designed with tables and diagrams to help the user as clear as

possible. If more information is needed to make the decision, then other parts of the handbook can be read as complement.

4. CHALLENGES

To produce a handbook that spans virtually the entire area of geodata capture is a large and time-consuming work. The biggest challenge in the geodetic part is to write the handbook in a way that it meets the demand from the users and to get the users to actually use the handbook.

The content of the handbook shall reflect the demands in the survey community and give support in the surveyor's daily work. To give this support it is mandatory to describe all surveying methods and techniques that are needed and useful. The handbook shall also be designed in a way that makes it easy to understand and to use both in the everyday fieldwork and in procurement procedures.

When the recommendations are any kind of numeric values,it is of most importance that the values are verifiedand tested properly. The challenge is to develop field tests and analysis methods that result in the actual recommendation values, and also to verify the correctness of the values.

The plan is to publish the geodetic part of the handbook during 2014. It will be a challenge to produce all sections and to have all investigations done in time.

5. CONCLUDING REMARKS

The geodata capture and surveying community in Sweden will benefit from having a collection of recommendations and standards that are adapted to Swedish conditions.

HMK, the Swedish handbook in surveying and mapping will provide support in the whole field of geodata capture and geodesy to the surveying community in Sweden. To offer support in such a wide area requires a major effort on coordination between different organizations. The HMK project is mainly coordinated from Lantmäteriet, but other authorities and organizations are involved as well.

REFERENCES

ISO/IEC Guide 98-3:2008Uncertainty of measurement -- Part 3: Guide to the expression of uncertainty in measurement (GUM:1995)Url: www.iso.org/sites/JCGM/GUM-introduction.htm

NORIN D,ENGFELDT A, JOHANSSON D, LILJE C, 2006: Short manual for surveying with SWEPOS Network RTK service. Rapportserie: Geodesi och Geografiska informationssystem, 2006:2, Lantmäteriet, Gävle.(In Swedish). Url: http://www.lantmateriet.se/Global/Kartor%20och%20geografisk%20information/GPS%20och%20m%c3%a4tning/Geodesi/Rapporter_publikationer/Rapporter/LMV-Rapport_2006_2_utgava3.pdf, visited 2014-03-17

ODOLINSKI R, 2010: Swedish User Guidelines for Network RTK. XXIV FIG Congress, Sydney 2010

ODOLINSKI, 2010b: User Guidelines for Network RTK. Rapportserie: Geodesi och Geografiska informationssystem, 2010:3, Lantmäteriet, Gävle. (In Swedish). Url: http://www.lantmateriet.se/Global/Kartor%20och%20geografisk%20information/GPS%20och%20m%c3%a4tning/Geodesi/Rapporter_publikationer/Rapporter/LMV-Rapport_2010_3.pdf, visited 2014-03-17

BIOGRAPHICAL NOTES

Anders Alfredssonis currently a developer at theGeodeticResearch Department of the National Land of Survey in SwedenHe graduated with a M.Sc. with emphasison geodesy and photogrammetry from the Royal Institute of Technology (Stockholm, Sweden) in 2002. He has been working at Lantmäteriet since 2002, mainly at the Geodetic Research Department.

Johan Sunna has a M.Sc. in the field of geodesy and photogrammetry from the Royal Institute of Technology in Stockholm received in 2009. He has since then beenworking as a geodesist specialised in GNSS surveying at Lantmäteriet – the Swedish Mapping,Cadastral and LandRegistration Authority.

Clas-Göran Persson is currently a Senior Geodesist at the Geodetic Research Department of the National Land Survey (NLS), and an Adjoint Professor in Applied Geodesy at The Royal Institute of Technology (KTH) in Stockholm. He has a PhD in Geodesy from KTH (1981) and has been an employee of NLS since 1984. He has been responsible for the work within HMK since 2009.

CONTACTS

Mr Anders Alfredsson
Lantmäteriet
SE-801 82 Gävle
SWEDEN
Tel. +46 771 63 63 63
Email: anders.alfredsson@lm.se
Web site: www.lantmateriet.se

Mr Johan Sunna
Lantmäteriet
SE-801 82 Gävle
SWEDEN
Tel. +46 771 63 63 63
Email: johan.sunna@lm.se
Web site: www.lantmateriet.se

Prof. Clas-Göran Persson
Lantmäteriet
SE-801 82 Gävle
SWEDEN
Tel. +46 771 63 63 63
Email: clas-goran.persson@lm.se
Web site: www.lantmateriet.se