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Status of mapping in the world

Study on the Status of Mapping in the World

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Background Paper

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Study on the Status of Mapping in the World

I. Introduction

1. Reference is made to the background paper E/C.20/2012/8/Add.1 of the 2nd Session of the Committee of Experts on Global Geospatial Information Management (UN-GGIM), held in New York, 13-15.August 2012.
2. This paper recalled, that in 1968, 1974, 1980 and 1987 the UN Secretariat has completed studies on the status of world topographic mapping. Topographic maps at that time constituted the basis for reliable geospatial information, as they do up until today.

Topographic maps were and are principally compiled by activities of the governmental national mapping agencies (NMA's). Representatives of these agencies of the UN member countries have regularly exchanged views on the status of mapping at the UN Regional Cartographic Conferences for Asia and the Pacific and for the Americas.

The issues of mapping have gained importance for the national and global management of resources and for sustainable development with increasing emphasis on environmental issues.

The last summary on the status of mapping has been published by the United Nations in its publication "World Cartography" in volume XX, published in 1990 (ST/TCD/14). It reflected the status of topographic mapping surveys up until the year 1986. As of 1980 the scope of mapping also began to include cadastral mapping, as a basis for land management issues.

The results of the published study for topographic mapping coverage of the land area of the world resulted in the following summary:

scale/range	1:25 000	1:50 000	1:100 000	1:200 000
Africa	2,9 %	41,4 %	21,7 %	89,1 %
Asia	15,2 %	84 %	56,4 %	100 %
Australia and Oceania	18,3 %	24,3 %	54,4 %	100 %
Europe	86,9 %	96,2 %	87,5 %	90,9 %
Former USSR	100 %	100 %	100 %	100 %
North America	54,1 %	77,7 %	37,3 %	99,2 %
South America	7 %	33 %	57,9 %	84,4 %
World	33,5 %	65,6 %	55,7 %	95,1 %

The survey also revealed that not only the coverage of maps was an important factor, but also the update rates of the topographic map. These were in summary:

scale/range	1:25 000	1:50 000	1:100 000	1:200 000
Africa	1,7 %	2,2 %	3,6 %	1,4 %
Asia	4,0 %	2,7 %	0 %	1,9 %
Australia and Oceania	0 %	0,8 %	0 %	0,3 %
Europe	6,6 %	5,7 %	7,0 %	7,5 %
Former USSR	0 %	0 %	0 %	0 %
North America	4,0 %	2,7 %	0 %	6,5 %
South America	0 %	0,1 %	0 %	0,3 %
World	5,0 %	2,3 %	0,7 %	3,7 %

Since the last publication of the data on the status of mapping there have been highly effective technology improvements in IT in sensor technology and in the availability of satellite platforms.

Foreseeing these technological advances, the UN Regional Cartographic Conferences (UNRCC) have passed a number of resolutions to update the effort on the status of mapping within existing resources.

3. In its resolution 3/IX, The Ninth UNRCC for the Americas, held in New York in 2009, has tasked the UN Secretariat to prepare a study on the status of mapping in the world to be directed to the national geospatial information authorities in the world.

In this context the International Society for Photogrammetry and Remote Sensing (ISPRS) has offered technical support to the UN Statistics Division, in charge of the UN-GGIM Secretariat.

4. In preparation for this survey by the UN-GGIM Secretariat, a questionnaire with 27 relevant questions characterizing the current official map coverage, its update status and the infrastructure for mapping in the country was jointly designed. It was sent out to the national geospatial information authorities of the U.N. Member States on April 27, 2012.
5. At the Second High-Level Forum on GGIM, held in Qatar, from February 4-6, 2013, the responses from 91 governmental mapping organizations in 90 U.N. Member States were discussed. Following the Forum, all analysis results were sent to these national geospatial information authorities for verification. 23 of these have made verification changes. The current status of results is presented in the background paper.
6. For the analysis of the survey an expandable database has been created, which permitted to present graphical outputs, country by country, analyzing the answers for the 27 questions of the questionnaire.
7. The United Nations cover the world in 193 member countries and a few non-member areas, while only 91 replies have been received. This is due mainly to the fact that some countries consider mapping as a security issue, and do not wish to officially report on it.
8. ISPRS has therefore made an additional attempt to obtain “unofficial” data for the existing map coverage from private map vendors. These data have also been utilized to permit an assessment for the coverage and age of the land areas mapped. Especially, the data from Eastview Geospatial, Minneapolis, Minnesota have been very helpful for this purpose.

9. Other multinational efforts have been initiated by the Multinational Geospatial Co-Production Program (MGCP) initiated mainly by NATO countries, which aims to compile a world digital coverage at medium scale.
10. A further assessment has been attempted to characterize the efforts by mapping industry to provide map data by new technologies used for geo-location by imagery and for navigational purposes. Even though it was very difficult to obtain complete information on these mapping data, for which accuracy and completeness specifications are not yet publicly available, the new IT efforts are an important supplement to “official” mapping by governments. Imagery provision for geo-location is considered to be more effective in providing up-to-date information quickly than standard governmental mapping operations relating to mapping objects.
11. In this connection crowd-sourcing efforts, which are made possible by mobile telephone technology linked with GPS should be mentioned. They have proven to be effective in emergency situations, such as the Haiti earthquake, and unrests monitored by Ushahidi in Kenya.
12. All these additional efforts do not replace governmental base mapping activities, but they permit to overcome some of the shortcomings of traditional mapping.
13. The author of the paper acknowledges the help received by Dr. Amor Laaribi and Ms. Vilma Frani of the UN-GGIM Secretariat to conduct the survey with the UN member countries and by Mr. Uwe Breikopf and Ms. Annette Radtke of the Institute for Photogrammetry and Geoinformation of the Leibniz University Hannover to design, build and administer the database for the project.

II. The Questionnaire sent out to UN Member States

14. The questionnaire intended to provide an overview of the current status of mapping the world with characteristic questions relating to the use of new technology for mapping and the cadastre including institutional arrangements on a national level.
15. Altogether 7 of the 27 questions of the questionnaire related to the National Topographic Mapping Coverage:
 - the scales of mapping in use in 8 categories (1:1000, 1:5000, 1:25 000, 1:50 000, 1:100 000, 1:250 000, 1:500 000, 1:1 000 000 or similar) and
 - 1) coverage of the data in km² or in % of the national area
 - 2) the age of map data
 - 3) restrictions imposed on the availability of maps
 - 4) maps for sale or for free
 - 5) procedure of map updates by map sheet or by features
 - 6) methodology for updating (field surveys, photogrammetry, satellite imagery, third party data, crowd sourcing)

- 7) in-house or outsourcing operations
16. A further 7 questions concerned the capability of a National Imagery Acquisition:
- 8) is there a national aerial photography program flown at regular intervals; are domestic services used; is the imagery analog or digital
 - 9) is there a national satellite imagery acquisition program providing images at regular intervals; are these domestic sources
 - 10) use of Radar or Lidar sensors
 - 11) is Lidar used for Digital Elevation Models (DEM's) and at which resolution
 - 12) are orthophotos produced and at which scale
 - 13) is there a national DEM
 - 14) is there the intention or use of 3D information for urban and rural landscape models
17. Altogether 8 questions were related to National surveying and the Cadastral Coverage:
- 15) are there licensed surveyors
 - 16) is there a national cadastral map coverage and is the NMA responsible for cadastral mapping
 - 17) what is the use of cadastral maps (titles, tax)
 - 18) are cadastral maps based on geodetic control
 - 19) are property boundaries monumented in the field
 - 20) are property maps updated
 - 21) number of employees or private surveyors engaged in cadastral operations
18. Further 6 questions concerned the Organisation of surveying and mapping:
- 22) is topographic mapping nationally funded
 - 23) annual mapping budget
 - 24) number of staff (total and technical) in NMA
 - 25) legal or regulatory mandate of NMA
 - 26) products in % supplied as
 - hard copy maps
 - digital data
 - online downloads

- web services

27) archival practices

III. Responses Received

19. 91 replies were received from 90 U.N. member countries plus 1 from Northern Ireland. See Fig.1 for the global distribution of these countries[†].
20. European replies (36) were nearly complete, except for Russia, Belarus and Montenegro (3). Small countries, such as San Marino, Liechtenstein or Monaco, which do not have own mapping administrations, were not included in the survey.
21. From the Americas the survey also returned good results (15), except for Argentina, Paraguay, Bolivia, Venezuela, Guyana, Suriname, Cuba, the Dominican Republic, the Caribbean Islands and the Bahamas.
22. Africa is partly covered (20). Missing are Angola, Congo, Democratic Republic of the Congo, Gabon, Nigeria, Sudan, South Sudan, Libya, Kenya, Djibouti, Tanzania, Somalia, Eritrea, Malawi, Mozambique, Zimbabwe, Swaziland, Lesotho, Benin, Liberia, Sierra Leone, Gambia, Mali, Chad, Central African Republic.
23. In the Pacific (3) most of the Island States are missing, as well as Antarctica.
24. The biggest gap of responses is from Asia (15): most of the middle-eastern Arab States, Central Asia, Afghanistan, Pakistan, India, Bangladesh, Myanmar, Thailand, Indonesia, Timor Leste, Democratic People's Republic of Korea (North Korea).
25. The replies cover only about 50% of the land areas of the globe.
26. Also not covered are bathymetry and hydrography of the ocean areas, which cover about 2/3 of the globe.

IV. Results of the Analysis

27. For the 91 countries and territories, which have replied, the analysis of the results by the Questions asked is as follows:

A) National Topographic Mapping Coverage

Question 1) Extent of existing Geodata or Map Coverage at various scale ranges

Most NMA's have only listed their coverage for the scales, for which they are responsible. No mention was made in some responses of the large scale coverage of urban areas under responsibility of the municipalities. This still needs to be locally verified.

[†] Please see the figures (Fig.1 – Fig.59) in the attached file to the background paper.

Some NMA's have provided graphical indexes of their map coverage, and some have even indicated the last update of the maps, but the supplied data were inconclusive with respect to the data coverage in km² or in % of the national area.

Some NMA's have listed links to their web-sites. Most of these are in their national languages. Again it is very difficult to extract the desired information.

Nevertheless, a map was derived to show the available largest scale coverage of the countries, which have replied. See Fig.2 to Fig.7 for the scale ranges 1:1000, 1:5000, 1:25 000, 1:50 000, 1:100 000 and 1:250 000 with the percentage of coverage for each country.

Fig.8 shows the average of the reported map scale ages from the countries, having reported them (47 countries). They usually refer to the largest scale at which the country was covered. 44 countries did not report on the map age.

Since some countries did not submit the information with sufficient clarity or did not respond at all, another approach had to be taken for those areas. The Eastview Geospatial database for ordering international maps has been analyzed to derive an estimate of the map coverage at different scale ranges for the land areas of the globe. A distinction has been made in 3 categories:

Fig.9 shows the coverage of maps at the largest available scale for maps produced by the country itself.

It is no secret, that countries, which have or had global security concerns did their own mapping of the globe. These were done by the US Defense Agencies and the Defense Agencies of the former Soviet Union. Their maps are now for sale by Eastview.

Fig. 10 shows the coverage at the largest available scale produced by the USA and Fig. 11 produced by the Russian Agencies.

Question 2) Current Age of Existing Geo-data

The Eastview database contains the dates of issues of the listed geo-data and maps for a country or region not having submitted a report. This permits to assess the actuality of the available global map content at the largest available scale shown in Fig. 12.

Question 3) Restrictions on Map Data Distribution

In most countries the maps are freely accessible without restrictions (65 countries). Only 21 countries (out of the 90) have restrictions on maps for the public. (See Fig. 13)

Question 4) Sale of Maps

In most countries map data are for sale in analog and digital form. In 67 countries maps or data are sold. (See Fig. 14). Generally only small scale overview maps are available through the web.

Only in 5 countries they are offered free of charge.

Question 5) Updating Strategy

76 countries out of 91 update their maps. 15 countries do not have updating programs. 46 countries carry out updating by map sheets and 30 by features (see Fig. 15).

Question 6) Updating Methodology

The methodology of updating in 33 countries is by photogrammetry supported by field surveys in large and medium scales, and from satellite images supported by field surveys and aerial imagery at small scales. 23 countries list a combination of photogrammetry and field surveys. 3 countries list field surveys only; 7 countries use aerial images only; and 2 countries use satellite images only. 9 countries utilize crowd sourcing combined with other methods (see Fig. 16).

Question 7) In-house Capabilities of NMA's

50 countries have in-house mapping operations, 12 countries practice outsourcing and 26 countries have both (see Fig.17).

B) National Imagery Acquisition

Question 8) National Aerial Imagery Program

55 countries have a national aerial photography program, 33 do not. 49 countries use digital imagery only; 11 countries use traditional analog imagery only; and 24 countries utilize both types. 7 countries do not have their own facilities (see Fig. 18 and 19).

Question 9) Satellite Imagery Uses by NMA

77 NMA's use satellite imagery for mapping. 11 countries do not (see Fig.20).

Question 10) Use of Radar or Lidar

Radar imagery is used in cloud prevalent countries, and Lidar is used in most developed countries. Developing countries have not introduced this technology. Altogether 47 countries use Radar or Lidar sensors, and 40 countries do not use them at all. (See Fig.21)

Question 11) Lidar DEM

Lidar is used for DEMS mainly in the developed world. 46 countries use it for DEM Generation.

Question 12) Orthophoto Program

Orthophoto technology is generally used in 80 countries to bridge the time gap for map updates. Only 6 countries do not use it (see Fig.22).

Question 13) National DEM

National DEM's are established in 64 countries, in 23 countries they are not (see Fig. 23).

Question 14) Interest in 3D technology by NMA

43 country NMA's are interested in 3D modelling information for viewing urban landscapes, while 41 are not (see Fig. 24).

C) National surveying and cadastral coverage

Question 15) Licensed Surveyors

72 countries have licensed surveyors for property surveys, 15 countries have not (see Fig.25).

Question 16) Responsibility for Cadastral Mapping and Cadastral Map Coverage

A national cadastral map coverage is available in 58 countries, but not in 27 countries (see Fig. 26).

Only 42 NMA's have the responsibility for the real estate cadastre. 45 countries have not (see Fig. 27)

Question 17) Use of Cadastral Maps

The use of cadastral maps is generally for securing titles (45), for taxation (39), for land registration (50), for conveyancing (36) and for other reasons (17).

Question 18) Cadastral Maps and Geodetic Control

In 74 countries cadastral maps are based on geodetic control, in 8 not (see Fig.28).

Question 19) Monumentation of Property Boundaries

In the majority of countries (61) property boundaries are monumented in the field, in 20 countries they are not (see Fig.29).

Question 20) Updating of Cadastral Maps

Updating of property maps in 68 countries is done by transaction procedures, in 23 countries this is not linked to transactions (see Fig.30).

Question 21) Number of Cadastral Employees

The number of employees or private surveyors engaged in cadastral operations is usually much larger than the personnel engaged in topographic surveys.

D) Organisation

Question 22) National Funding for Mapping

Topographic mapping is nationally funded in 78 countries, in 6 countries it is not (see Fig. 31).

Question 23) Mapping Budget

Some countries list their budget and this is proof that mapping is a very substantial highly regarded operation.

Question 24) NMA staff

The number of staff engaged in mapping in the developed countries exceeds the number of staff in the developing countries.

Question 25) Legal Status of Mapping

In most countries (79) NMA's have legal or regulatory status, in 5 countries they have not (see Fig. 32).

Question 26) Form of Map Products Supplied

Even in developing countries the supply of digital map data exceeds that of analog products. Online and web delivery of map data is generally only available in developed countries. 56 countries list hard copy maps as possible output, 55 digital media, 31 downloads and 29 the web.

Question 27) Archival of Geodata

All countries care about archiving their map data in analog or digital form. 37 countries use servers, while 39 use other methods (see Fig. 33).

28. Fig. 34 to Fig. 45 describe the result by comparing the 91 country replies for a number of pertinent questions:

Fig. 34 shows, that 1:50 000 is the most frequently used map scale.

Fig. 35 shows, that most countries sell their data.

Fig. 36 demonstrates, that 84% update their maps, that for 74% photogrammetry is the tool and in 84% of the cases this is done in-house.

Fig. 37 shows, that 60% of the countries have a national aerial photography program;
In 71% of the countries satellite imagery is acquired on demand, not on a regular Basis.

Fig. 38 shows, that only 64% of the countries has a national cadastre coverage, but in 81% of the countries geodetic control is used in cadastral surveys.

Fig. 39 shows, that 93% of the countries use paper maps as a product, but in 92% of the countries also digital data are provided, but only in 44% of the countries by web.
In only 41% of the countries the data archival is on servers. In 54% of the countries it is still on DVD's.

Fig. 40 and Fig. 41 analyze the map scale distribution in Europe versus Africa. In both Cases 1:50 000 is the dominant map scale.

Fig. 42 and Fig. 43 compare the national imagery programs of Europe and Africa
In Europe 89% of the countries use digital aerial photography. In Africa it is only 40%.

Fig. 44 and Fig 45 compare the property cadastre in Europe and the Americas.
In Europe a national cadastral coverage exists in 78% of the countries.
In America it only exists to 27%, but cadastral survey updates are customary on Transaction (Europe 81%, the Americas 87%).

29. Fig. 46 to Fig. 59 make an attempt to characterize the immense efforts of independent private industry mapping providers. These are engaged in the mapping scene for different Purposes. All make use of authoritative governmental map data to the extent, where these are freely or commercially available. The lack of object related data in vector format are substituted by imagery acquired from high resolution satellite data providers or from data obtained from aerial survey efforts. In some cases the lack of up-to-dateness of the maps is compensated by own vectorization efforts, which are mostly not to governmental accuracy standards, but fulfil the need for quick updates. This may even include crowd sourcing efforts merged with own quality control checking procedures.

All figures are taken from websites of the private industry mapping providers. These are of course of low graphic quality. Maybe in the future it might be possible by cooperation with these industrial partners to include images with higher graphic quality.

Fig. 46 shows the coverage of “Google Maps” (in green using governmental inputs, Google Street Map and the Google Ground Truth program; in blue to use possible inputs from partners; and in red using mostly satellite imagery)

Fig. 47 describes the efforts of the “Google Ground Truth “ program which collected up-to-date information for 43 countries in 5 years for Google’s objectives.

Fig. 48 shows the coverage of “Google Street View”, which has been carried out regardless of whether the data have been used on the web in public or for internal purposes only

Fig. 49 show the efforts of Microsoft Bing maps to provide a coverage of 30cm ground sampling distance (GSD) using Microsoft-Vexcel digital aerial cameras over the USA and Western Europe, including such 15cm GSD images of the urban centers of these regions.

Fig. 50 to Fig. 57 are excerpts of the Navteq database to show progress in road navigation mapping for the countries of the globe (Fig.50 for Australia, Fig. 51 for Brazil, Fig.52 for China, Fig. 53 for Germany, Fig.54 for India, Fig. 55 for Kenya, Fig. 56 for the USA, Fig 57 for Russia including Siberia)

Fig. 58 shows the TomTom navigation map coverage over the world

Fig. 59 is an example of a crowd sourcing map compiled by private citizens of Kenya, giving information on riots provided by mobile telephones within the Kenya telecommunication networks.

V. Conclusion

30. The 91 responses of the questionnaire are considered as a favourable result to characterize the current state of authoritative mapping at a time of wide expansion of the technical possibilities. A periodic follow-up process is continuing from the GGIM Secretariat with the help of regional committees.

31. ISPRS has also addressed their national member organisations to solicit further official responses by personal contacts. For this purpose a working group has been established within its Technical Commission IV (Geospatial Databases and Location Based Services), which permits to analyze the status of mapping as a sustainable effort.

32. Examples of private sector efforts and their global coverage are added for information, as an attempt to invite the mapping industry partners to share with the global mapping community their continuing and recent efforts to provide up-to-date map data.

