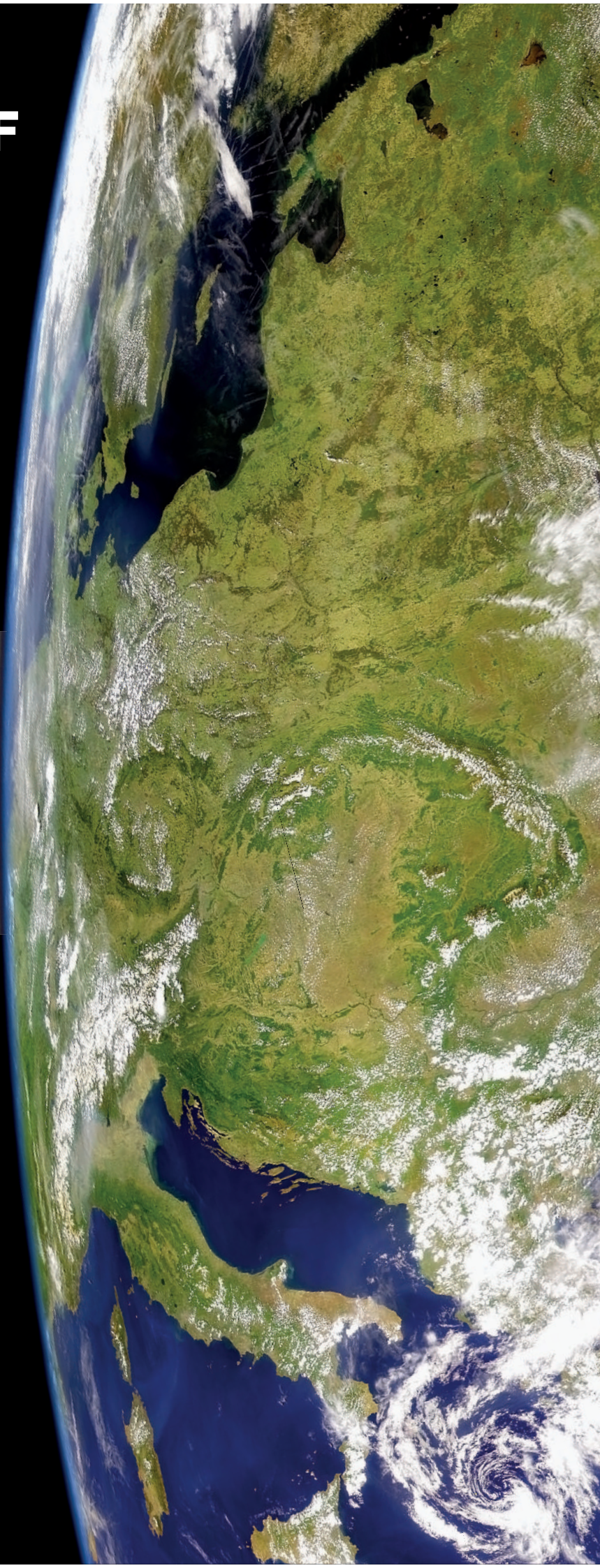
THE STATUS OF TOPOGRAPHIC MAPPING IN THE WORLD



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A UNGGIM - ISPRS PROJECT 2012 - 2015

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THE STATUS OF TOPOGRAPHIC MAPPING IN THE WORLD A UNGGIM - ISPRS PROJECT 2012 - 2015

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Abstract

In December 2011 UNGGIM initiated a cooperative project with ISPRS to resume the former UN Secretariat studies on the status of topographic mapping in the world conducted between 1968 and 1986. After the design of a questionnaire with 27 questions, the UNGGIM Secretariat sent the questionnaires to the UN member states. 115 replies were received from the 193 member states and regions thereof. Regarding the global data coverage and age the UN questionnaire survey was supplemented by data from the Eastview database. For each of the 27 questions an interactive viewer was programmed permitting the analysis of the results. The authoritative data coverage at the various scale ranges has greatly increased between 1986 and 2012. Now a 30% 1:25 000 map data coverage and a 75% 1:50 000 map data coverage has been completed. Nevertheless there is still an updating problem as date for some countries are 10 to 30 years old. Private Industry with Google, Microsoft and Navigation system providers have undertaken huge efforts to supplement authoritative mapping. For critical areas on the globe MGCP committed to military mapping at 1:50 000. ISPRS has decided to make such surveys a sustainable issue by establishing a working group.

1 Origins of the Project

In 1986 the Department of Technical Cooperation for Development of the United Nations Secretariat has completed the last survey on the „Status of World Topographic and Cadastral Mapping“. The results of the survey were published by the United Nations, New York 1990 in World Cartography, Vol. XIX. The text was submitted by the UN Secretariat as document E/CONF 78/BP7 in 1986 prepared by A.J. Brandenberger and S.K. Ghosh of the Faculty of Forestry and Geodesy at Laval University, Quebec, Canada. It referred to previous surveys submitted by the Department of Technical Cooperation for Development of the United Nations Secretariat in 1968 published in World Cartography XIV and in 1974 and 1980 published in World Cartography XVII.

The paper published in World Cartography XIX in 1990 summarized the progress made in topographic mapping across the globe between 1968 and 1980 in 4 scale categories:

range I; scales between 1:1000 and 1: 31 680
range II; scales between 1:40 000 and 1:75 000
range III; scales between 1:100 000 and 1:126 720
range IV; scales between 1:140 000 and 1:253 440

These ranges represent the more recently standardized scales:

range I; scale 1:25 000
range II; scale 1:50 000
range III; scale 1:100 000
range IV; scale 1:250 000

While scale in the age of digital cartography has changed the meaning, the scale ranges nevertheless maintain their significance with respect to the resolution of mappable details.

The 1986 survey covered the following number of countries or territories:

Africa	53 countries	4 territories
North America	24 countries	13 territories
South America	12 countries	3 territories
Europe	39 countries	4 territories
Asia	40 countries	3 territories
USSR	1 country	0 territories
Oceania	11 countries	17 territories

Antarctica was not included in the survey.

Source of the data obtained by the surveys were completed questionnaires, sent by the UN Secretariat to the UN member countries, plus additional surveys made directly by Laval University for UN member countries not having answered the questionnaires, for non-UN member countries and for territories under foreign administration. The result of the survey was for each region and for the different scale ranges:

	range I	range II	range III	range IV
Africa	2.3%	29.7%	20.6%	86.8%
North America	41.3%	68.2%	8.0%	92.8%
South America	9.7%	29.0%	44.2%	50.4%
Europe	92.5%	93.8%	81.3%	95.7%
Asia	16.0%	62.7%	65.4%	92.0%
USSR	>5%	>60%	100%	100%
Oceania	13.3%	15.6%	36.1%	99.8%

The areas covered by the survey were:

	range I	range II	range III	range IV
Africa	75.8%	100%	100%	100%
North America	90.7%	100%	100%	99.5%
South America	100%	100%	100%	100%
Europe	98.0%	90.2%	97.25%	96.7%
Asia	87.8%	90.9%	87.6%	90.2%
USSR	100%	100%	100%	100%
Oceania	94.1%	94.5%	94.3%	99.9%

World summary:

	range I	range II	range III	range IV
area of survey 1986	90.1%	97.4%	97.0%	97.75%
1986 map coverage	17.9%	49.3%	46.4%	87.5%
1980 map coverage	13.3%	42.2%	42.2%	80.0%
1974 map coverage	11.6%	35.0%	40.5%	80.5%
1968 map coverage	7.7%	23.4%	38.2%	81.0%

Since the last survey in 1986 considerable progress has been made in data coverage:

	range I	range II	range III	range IV
2012 map coverage	33,5%	81.4%	67.5%	98.4%

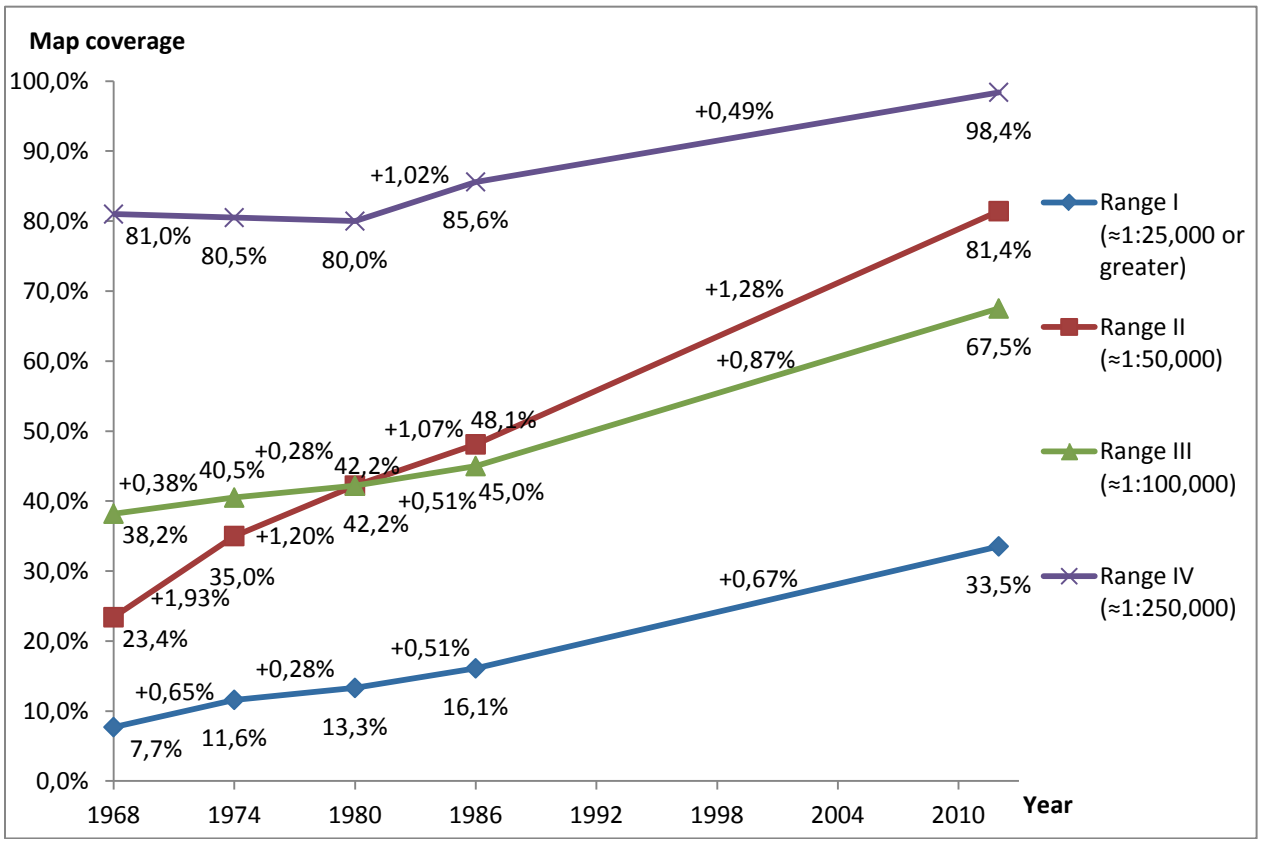


Chart 1: Percentages of total world area covered in each scale category, 1968-1974-1980-1986-2012

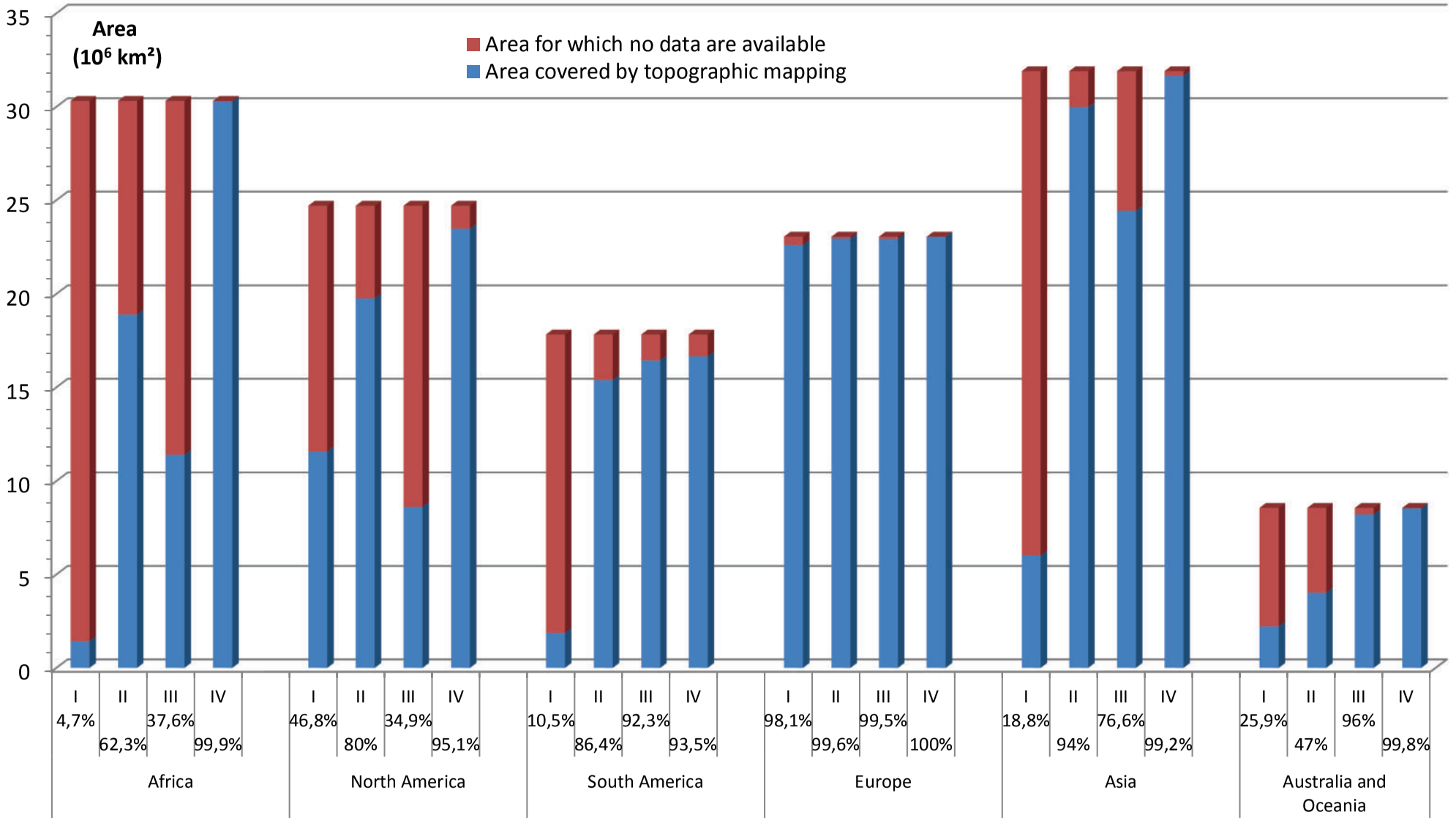
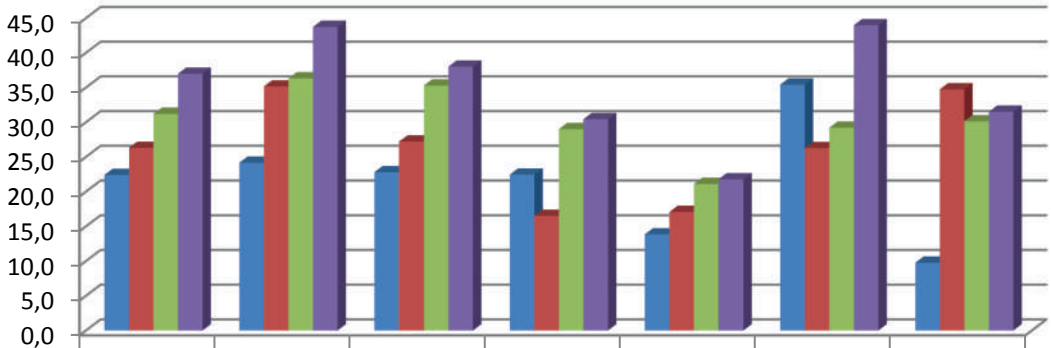


Chart 2: Area covered by topographic mapping on four scale ranges, by geographical region, 2012

While the surveys presented in 1986 did not concentrate on map revision on a global basis, they nevertheless derived an update rate for the four scale ranges:

	range I	range II	range III	range IV
update rate 1986	3.2%	1.8%	2.7%	3.6%

This points to the fact, that in 1986 the maps at the scale relevant to national planning operations 1:50 000 were hopelessly out of date.



	Global	Africa	Asia	Australia and Oceania	Europe	North America	South America
Range I	22,4	24,2	22,8	22,4	13,8	35,4	9,8
Range II	26,3	35,1	27,2	16,5	17,1	26,3	34,7
Range III	31,2	36,3	35,3	29,0	21,1	29,2	30,1
Range IV	37,0	43,7	38,0	30,4	21,8	44,0	31,5

Chart 3: Average map age in years counting from 2012

Other aspects of the surveys conducted in 1980 were directed toward the existence of geodetic networks and their density. In 1980 there existed 3.67 M horizontal and 3.16 M vertical control monuments on the globe, but again their density varied from 2.66 km^2 per horizontal control monument and 3.61 km^2 per vertical control monument in Europe to 232 km^2 in Africa with an average of 42.5 km^2 per horizontal control monument to 46.4 km^2 per vertical control monument.

Today the GNSS technology makes control point densities irrelevant, except for the case, when old map data need to be referenced to a global datum.

In 1980 the national mapping agencies possessed 12 120 theodolites, 5790 precise leveling instruments and 1914 EDM devices, 162 airplanes for aerial photography, 267 aerial survey cameras and 3120 photogrammetric stereo plotting instruments. Disregarded in that survey are instruments owned by companies mapping for governments under contract.

Again, the availability of geodetic instrumentation is not of essence to judge progress any more. The attempts of 1980 to determine the existing manpower of the national mapping agencies for each region were based on few countries only (e.g. Algeria and Nigeria for Africa, the USGS in the USA, the Surveys and Mapping Branch in Canada, the IGN France in Europe). These data were used to extrapolate the requirements in other countries with the attempt to develop a budget of global expenditures, yielding a global sum of US$ 868 million, at that time 0.010% of the gross national product, while the global surveying and mapping activities at that time were estimated to be between 8 to 9 billion US$ per year. A program for

increasing the expenditures to 0.02% of the GNP was recommended in the report to meet the need for lacking mapping coverage and lacking map updates.

The financing of geospatial information is a very complex issue. To track progress these tasks should now be transferred to another UNGGIM Working Group

The rather inaccurate and inconclusive results of 1986 may have discouraged the UN Secretariat in continuing the past surveys due to lack of a budget for this purpose.

2 The UNGGIM-ISPRS Project

The United Nations Regional Cartographic Conferences (UNRCC) for the Americas and for Asia and the Pacific nevertheless continued to recommend to the Secretariat to continue the studies on the global status of mapping. One of these resolutions of the UNRRCC for the Americas in 2009 gave the mandate to the Secretariat for a new survey.

This happened at the time, when UNGGIM (United Nations Global Geospatial Information Management) was created as a new structure.

ISPRS approached the director of UNGGIM in 2011 to start a joint project on the survey of the status of topographic geospatial information,

- because the issue is of global interest
- because new technologies, such as GNSS (GPS, GLONASS), digital aerial mapping, high resolution satellites for mapping, digital photogrammetry and GIS have taken over as new mapping methodologies
- because large private organizations such as the navigation industry (HERE, TomTom),

  Google Earth and Microsoft Bingmaps have entered the mapping effort, which was previously the domain of the national mapping agencies.

The project was approved in December 2011 by Dr. Paul Cheung, director of UNGGIM at that time, who nominated Dr. Amor Laaribi as UNGGIM contact, and by Chen Jun, President of ISPRS, who nominated Prof. Gottfried Konecny of Leibniz University Hannover as ISPRS contact.

In January 2012 a questionnaire to the UN member states was designed, mutually discussed, translated to French, Russian and Spanish and mailed to the contacts of the UNGGIM Secretariat in the UN member states. Ms. Vilma Frani of the UNGGIM Secretariat sent the replies to Leibniz University Hannover, where they were placed in a database designed by Uwe Breitkopf for further analysis.

3 The Questionnaire

The jointly designed questionnaire consists of five parts including 27 Questions:

- PART A: Background Information
- PART B: National Topographic Mapping Coverage
- PART C: National Imagery Acquisition
- PART D: National Surveying and Cadastral Coverage
- PART E: Organization

See Appendix I for the original questionnaire.

Until June 2015 altogether 115 responses have been received from 193 UN member states or regions thereof. In addition, there are 51 non-UN member countries and territories, which are also covered by map data. These map data for 244 UN member states and regions were generated in UN member states, but these have in general no direct responsibility for mapping these territories.

Fig. 1 shows the 115 states or regions from where replies have been received, which have answered the UNGGIM-ISPRS questionnaire.

Answers were almost complete from Europe (with the exception of Belarus), they were satisfactory from the Americas (with the exception of Argentina) and in Oceania. In Asia India, Pakistan, Myanmar, Kazakhstan, some Central Asian countries and Indonesia did not participate in the survey. In Africa about half the countries did not share their information. Nevertheless the response by 115 member states and regions thereof from 193 UN Member States is considered a success by the UN.

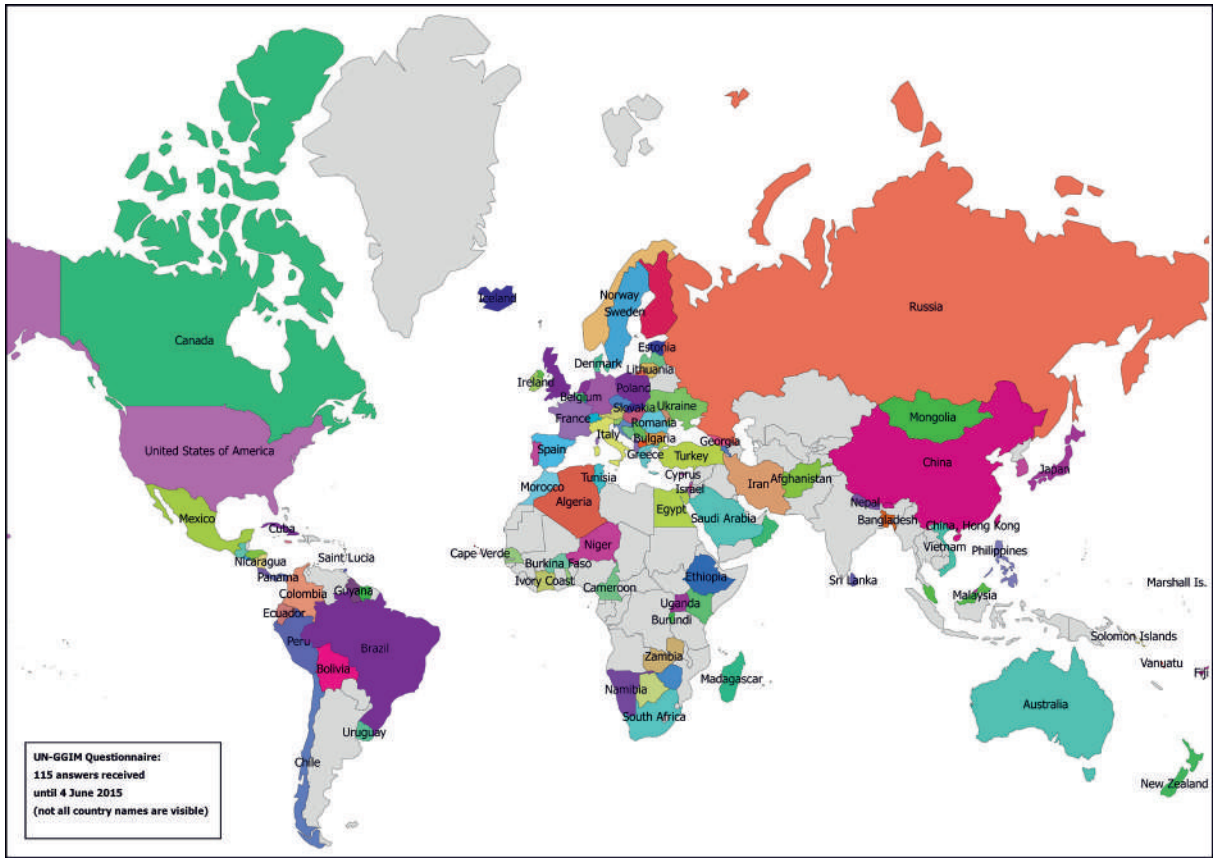


Fig. 1: 115 countries have replied the Questionnaire until June 2015

4 Content of the Database

While not all of the 27 questions need to be answered globally, this is, however, important for questions 1 and 2, since they characterize the global data coverage at the different scale ranges and their age of the data.

To assess the global status of map coverage the Eastview database is a fundamental component to answer these questions. Dr. Kent Lee, CEO of Eastview has kindly agreed to make the missing data available from their database.

The map sources at Eastview include locally produced (e.g. by national mapping agencies) as well as military map series, see Appendix II-13 and 14 as an example.

Besides Eastview other sources were analyzed to fill the gaps in the study and estimate global coverage. These include UN reports accompanying the questionnaires, internet portals for national mapping data, the cartographic database of the German State library of Berlin based in part on the Geokatalog of the map vendor ILH Stuttgart and others see Appendix II to IV for examples.

Regarding question 1 Fig. 2 to Fig. 5 show the global coverage in the scale ranges 1: 25 000 or greater, 1: 50 000, 1: 100 000 and 1: 250 000.

Europe, the Russian Federation, Turkey, Japan and the continental USA are well represented in the 1:25 000 scale range, as well as the Western part of China. In the remainder of the world that scale range only covers a small part of the countries.

The scale range 1:50 000 and larger, on the other hand covers the continents of Europe, North America, Asia and the Arab world, most of South America and New Zealand. Australia and Algeria are covered to about 40% to 60% and Mongolia to about 30%. Only in the desert areas of the Africa and South America the coverage is less than 15%.

Australia and Papua-Niugini are fully covered by 1:100 000 maps, as well as Latin America. With few exceptions the land areas of the globe are covered at the 1:250 000 scale range with the exception of Greenland with 45% and Antarctica with 4%.

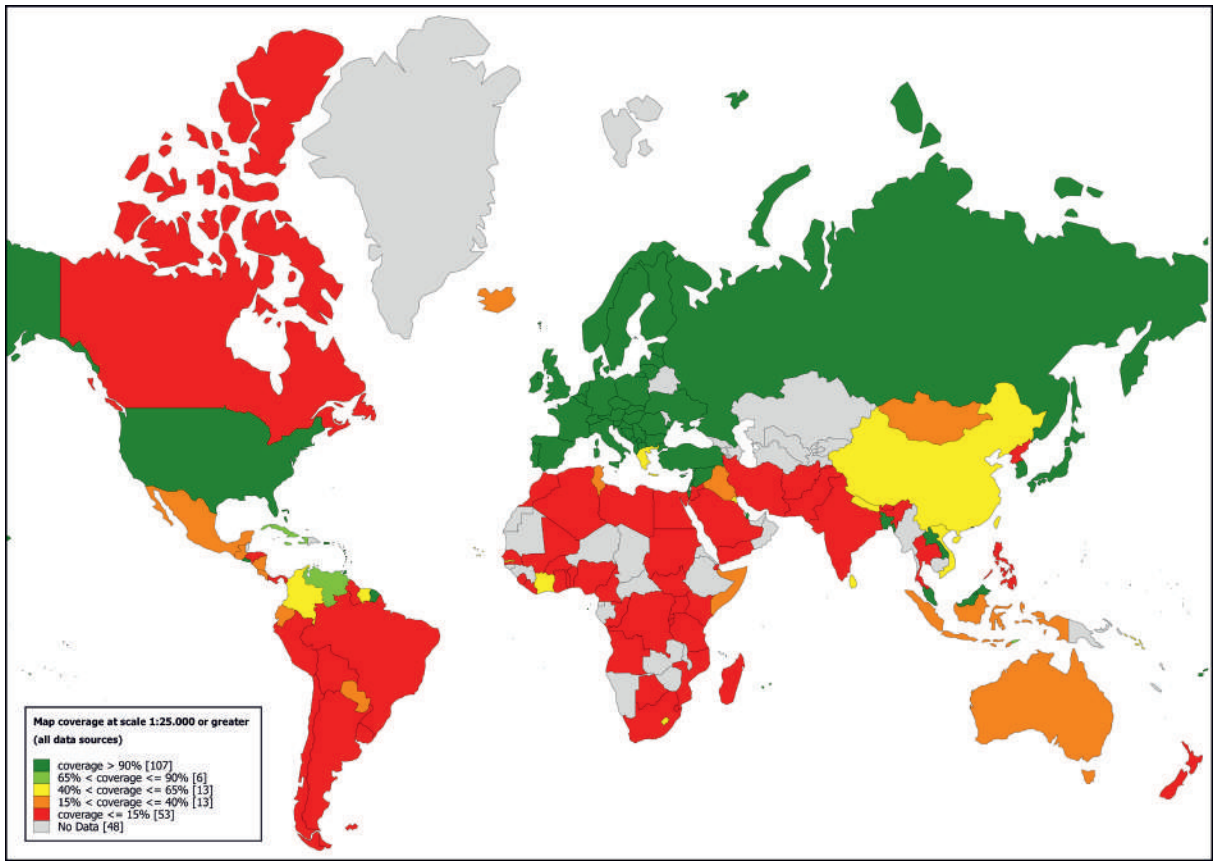


Fig. 2: Map coverage at scale 1:25 000 or greater

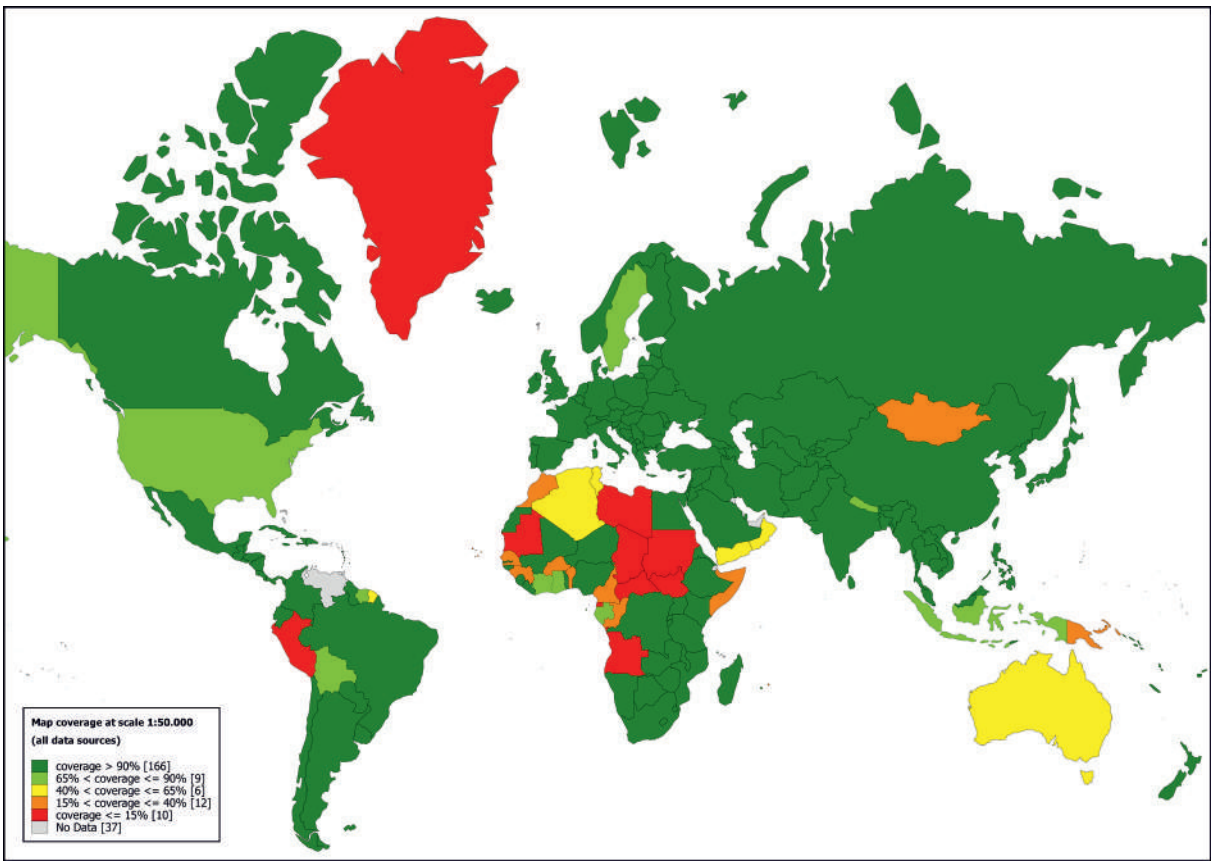


Fig. 3: Map coverage at scale 1:50 000

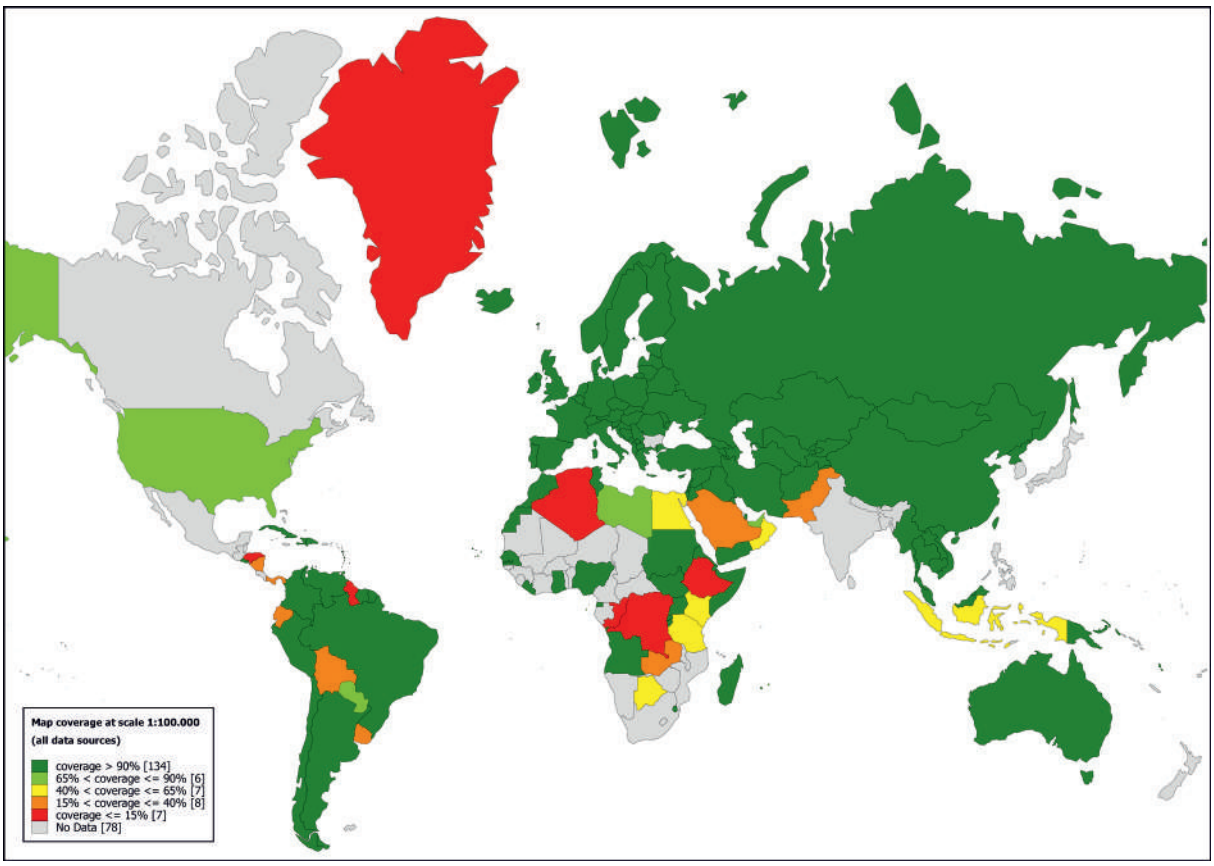


Fig. 4: Map coverage at scale 1:100 000

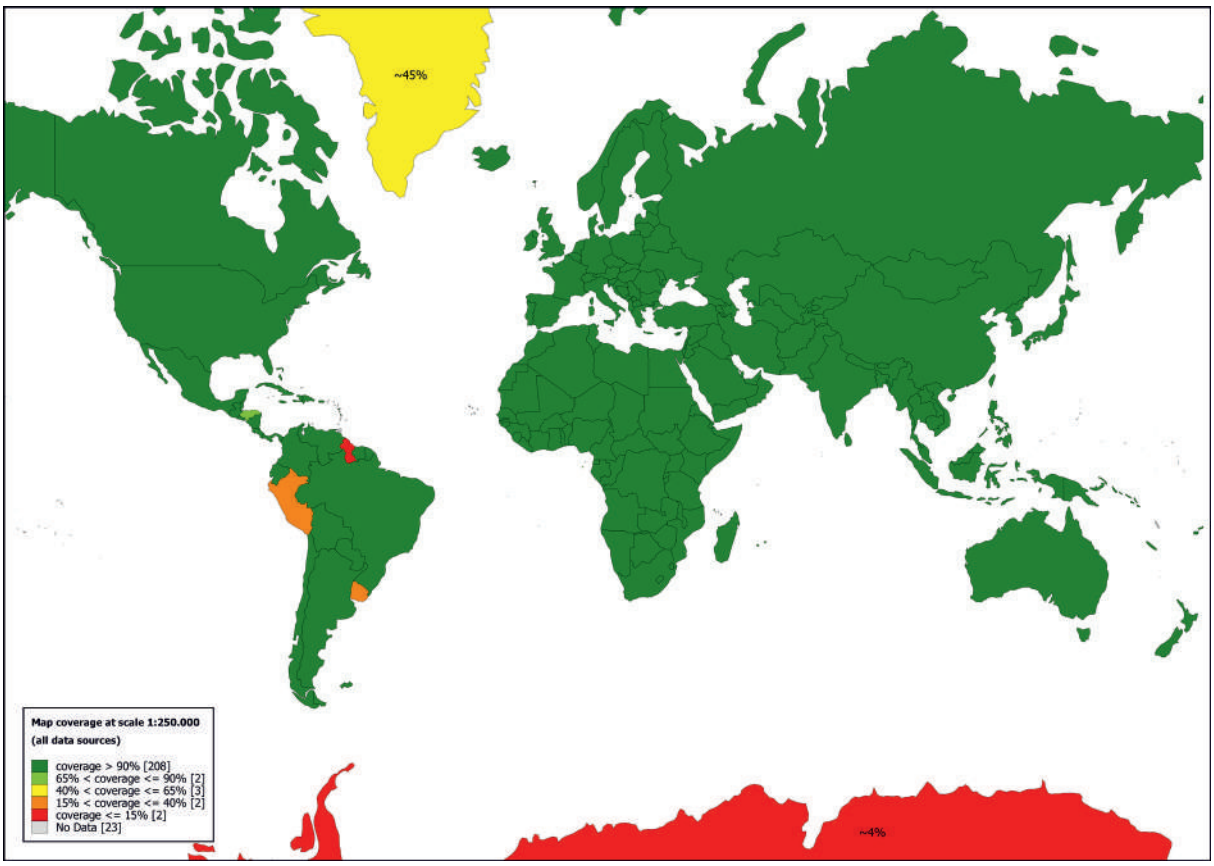


Fig. 5: Map coverage at scale 1:250 000

With only 59% of the UN member states having answered the questionnaire, other sources had to be utilized to assess the global coverage. Chart 4 and Fig. 6 to Fig. 9 give the source of the Meta data information for Fig. 2 to Fig. 5.

Concentrating on the globally important scale range 1:50 000 only 22% of the relevant information stems from the questionnaires received. 5.4% are added from country reports to UNGGIM, 2.9% from Internet portals. 12% of the metadata came from Eastview, 19.1% from the State Library Berlin plus 5.8% from other sources and 17.4% on what has previously been compiled by Laval University in the 1986 study, totaling 91% of the information.

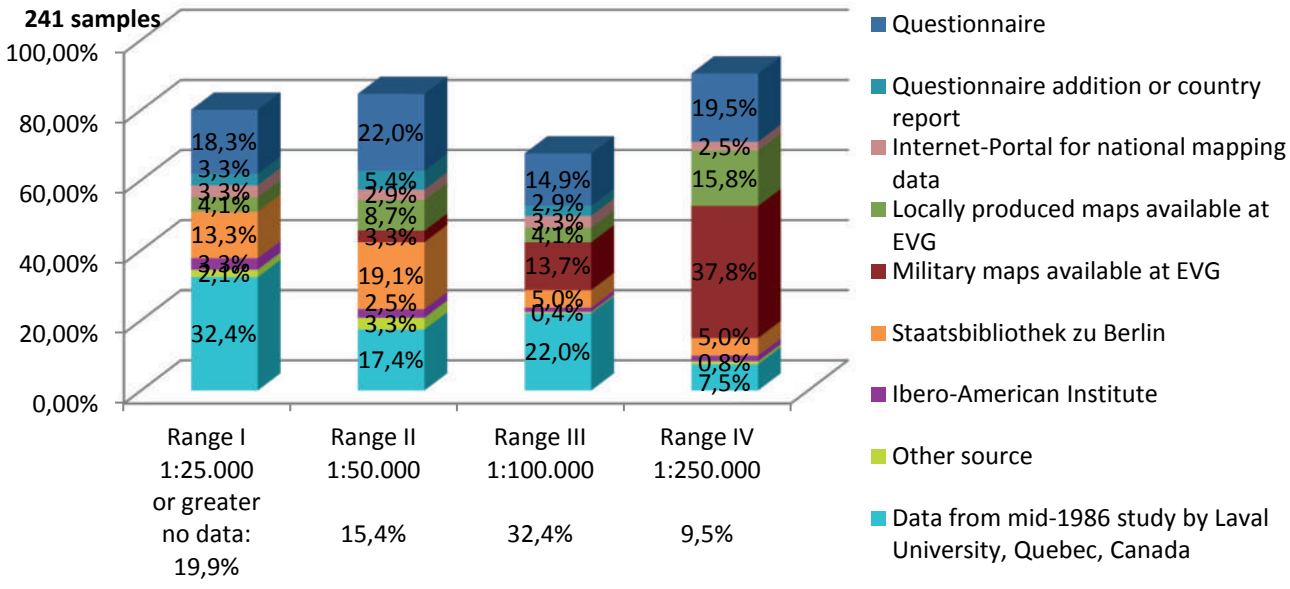


Chart 4: Data source for coverage per scale category

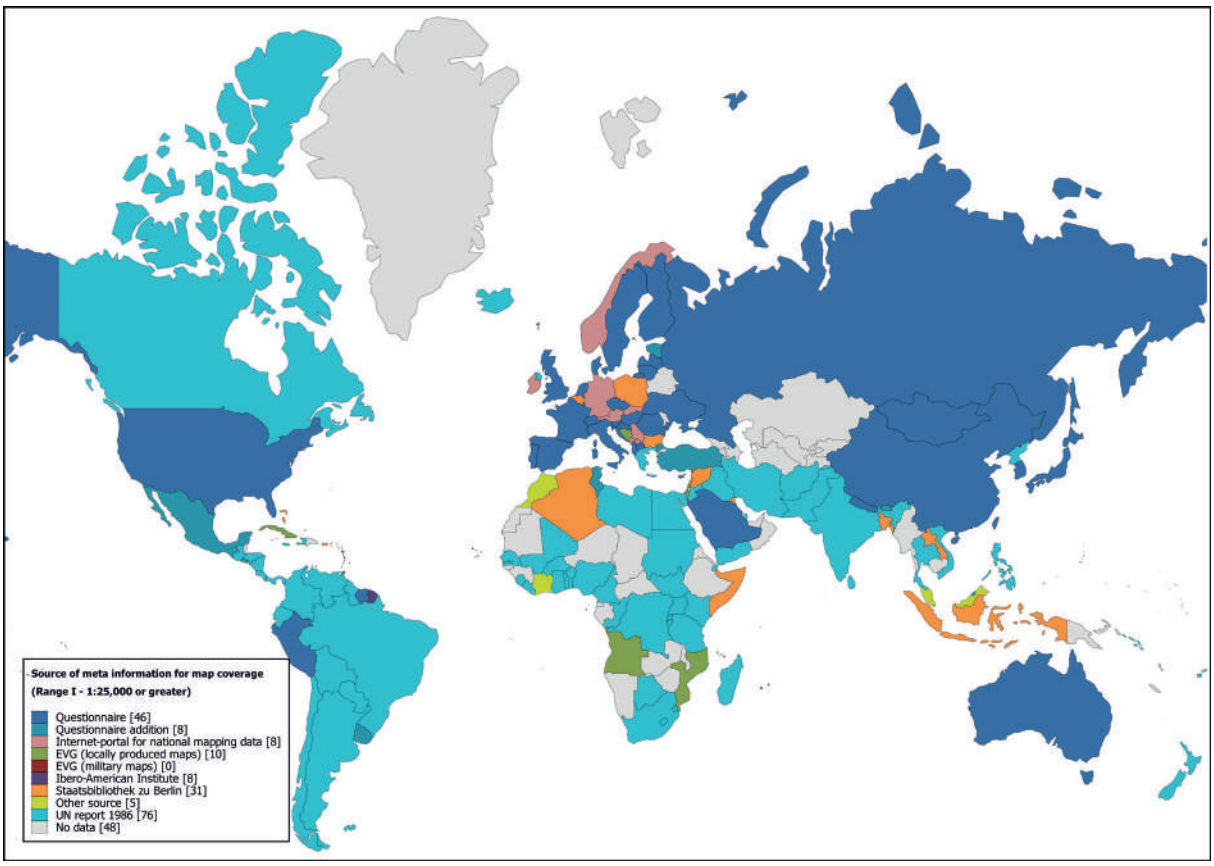


Fig. 6: Source of Meta information for map coverage in range I - 1:25,000

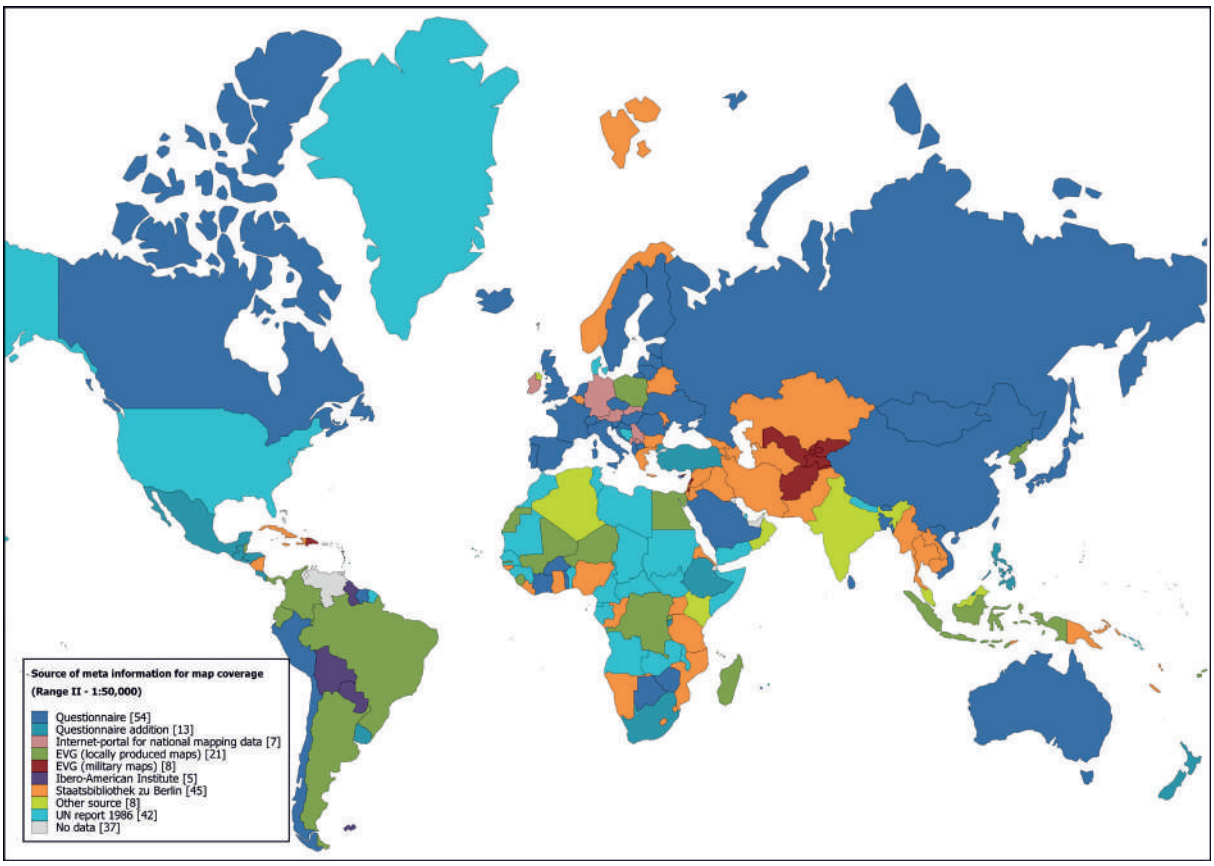


Fig. 7: Source of Meta information for map coverage in range II - 1:50,000

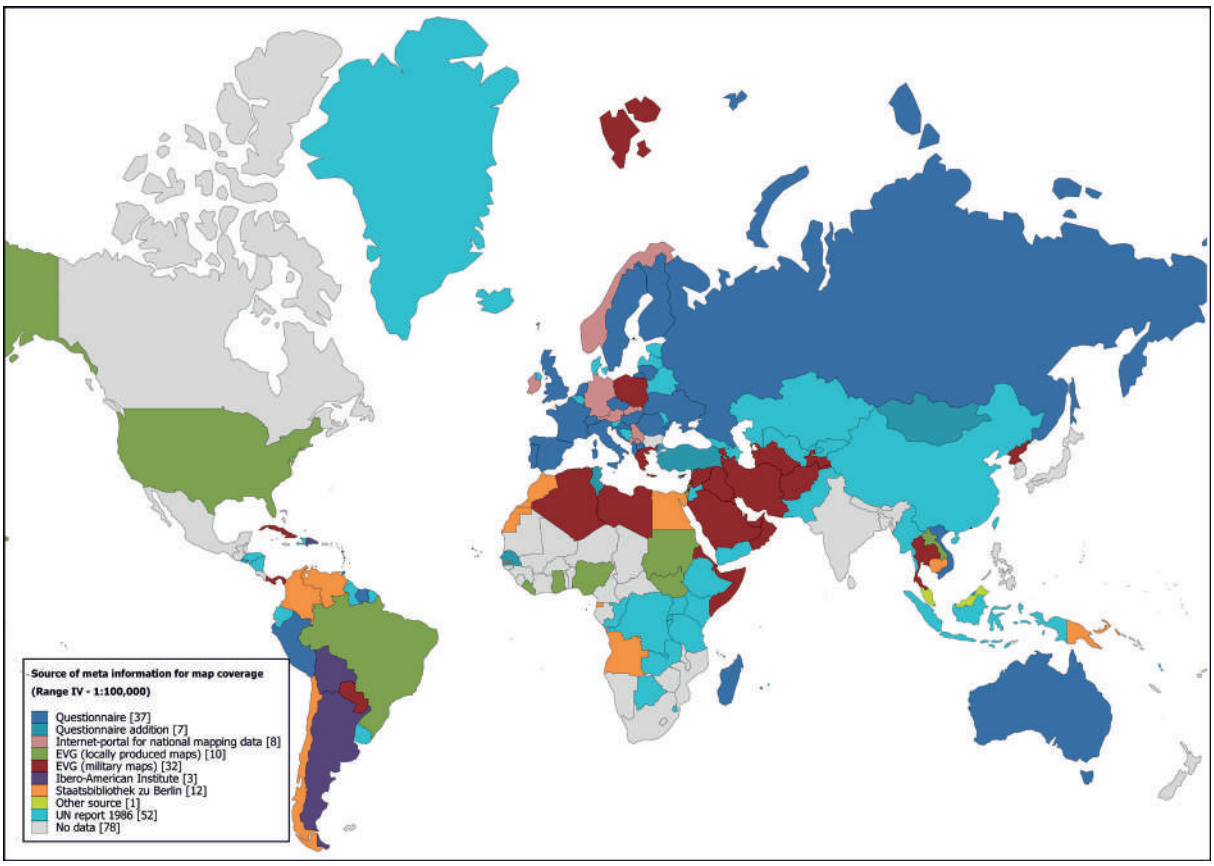


Fig. 8: Source of Meta information for map coverage in range III - 1:100,000

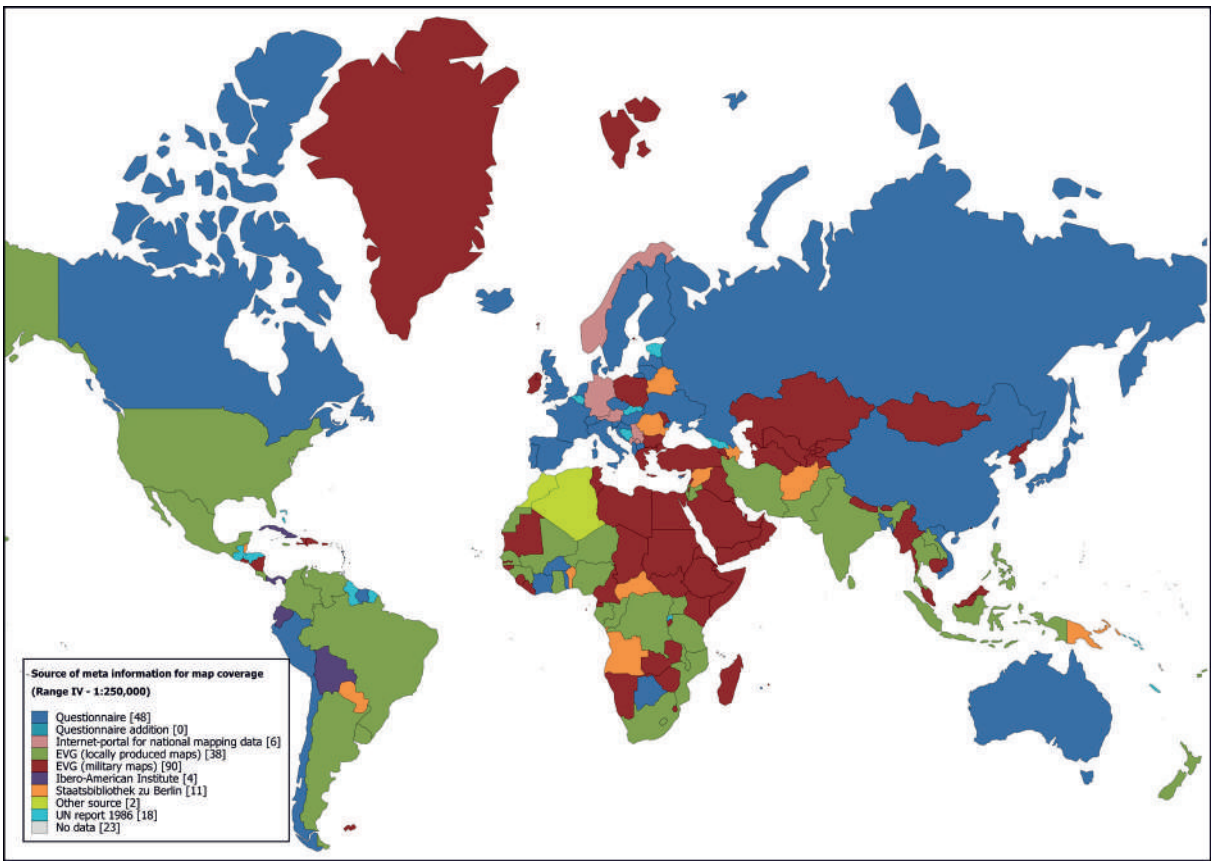


Fig. 9: Source of Meta information for map coverage in range IV - 1:250,000

Fig. 10 to Fig. 13 shows the equivalent data to Fig. 2 to Fig. 5 for the year 1986, depicting the huge progress made through technology from 1986 to 2012. Also Fig. 14 highlights the change in map coverage between 1986 and 2012.

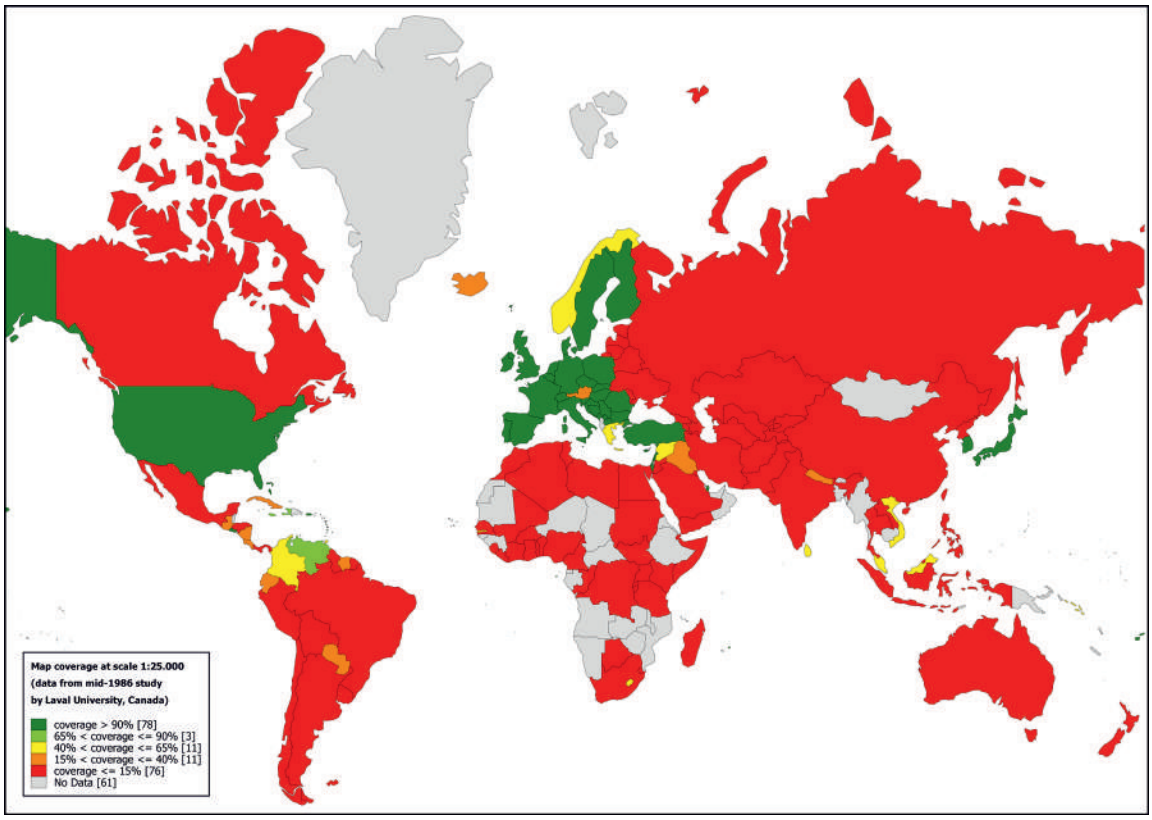


Fig. 10: Map coverage 1986 at scale 1:25 000 or greater

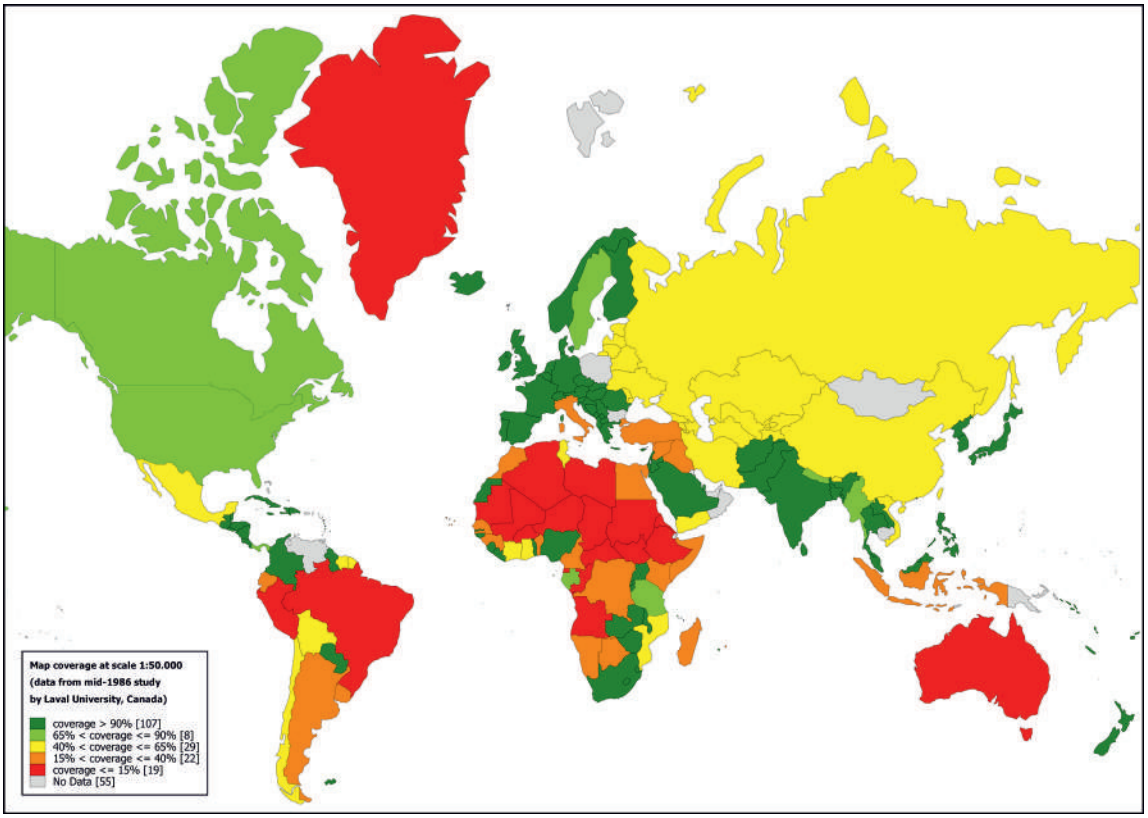


Fig. 11: Map coverage 1986 at scale 1:50 000

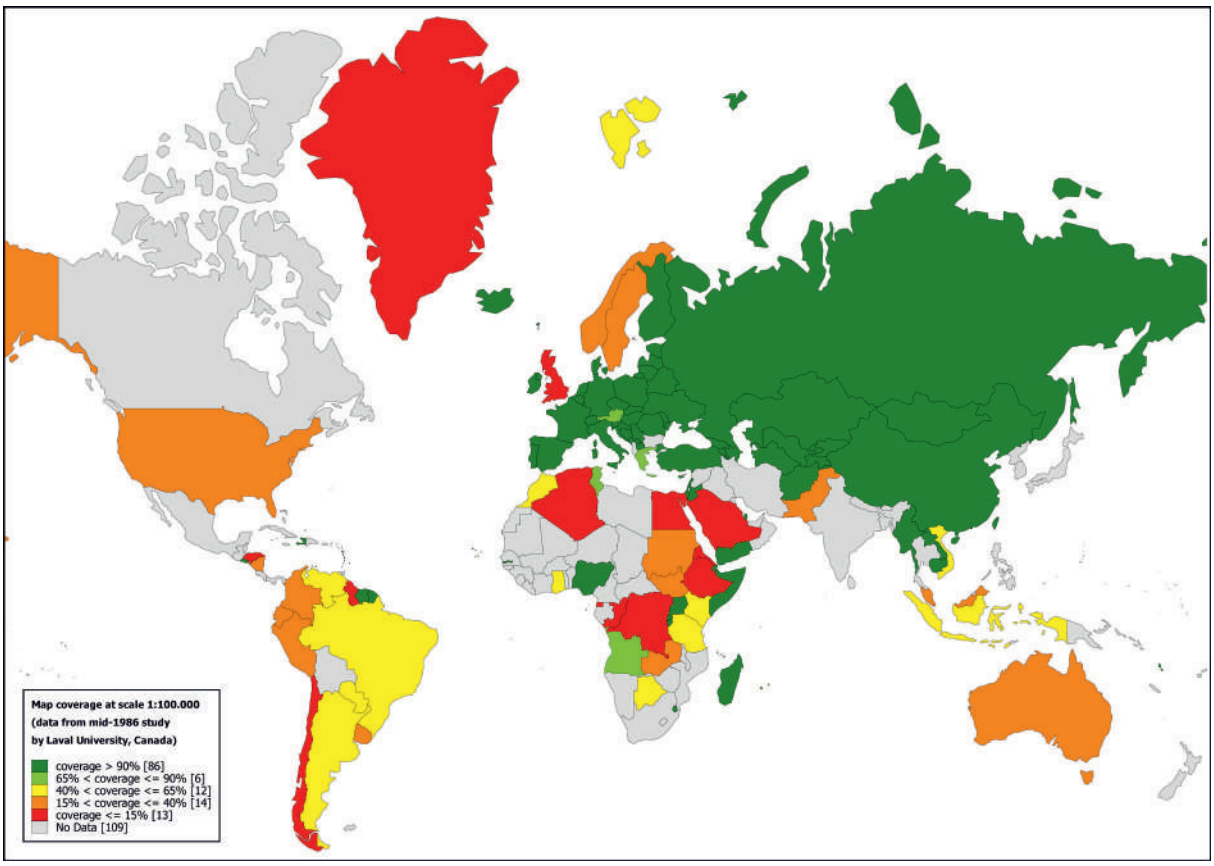


Fig. 12: Map coverage 1986 at scale 1:100 000

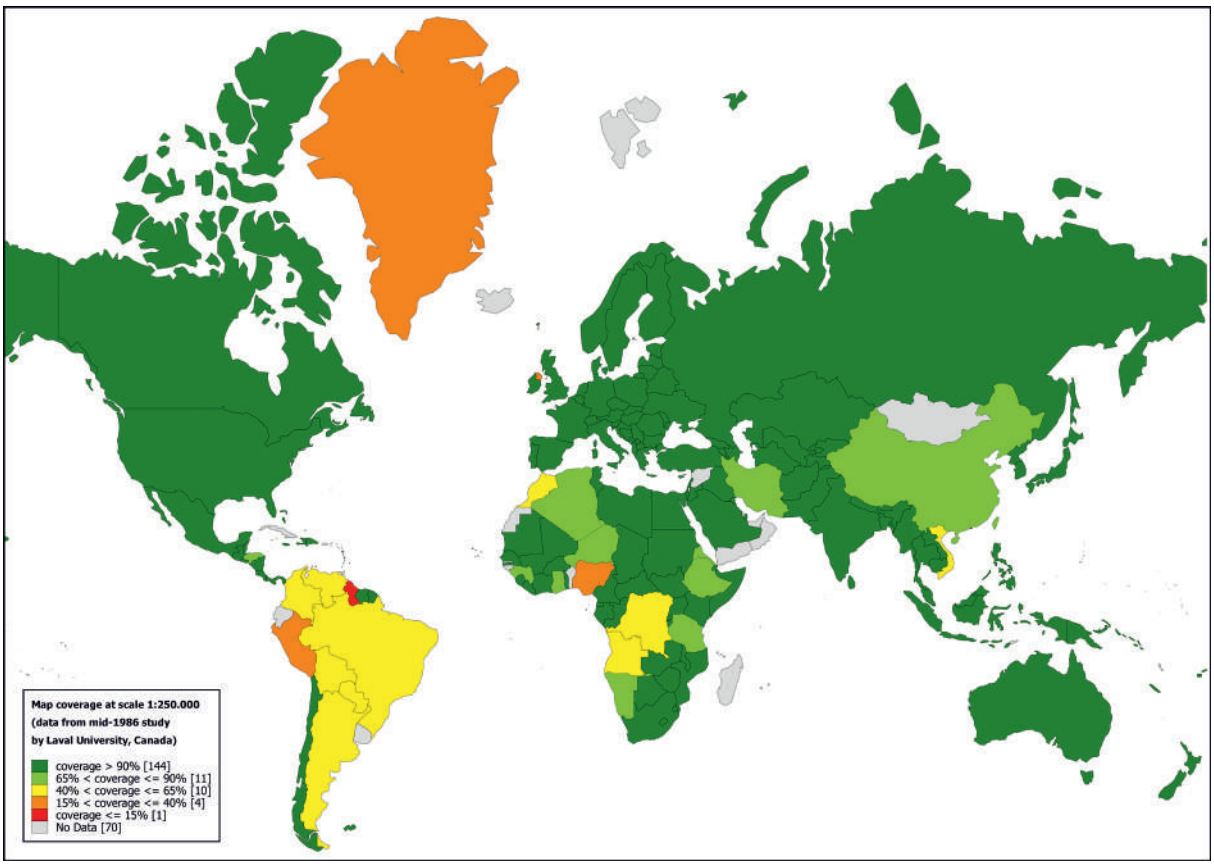


Fig. 13: Map coverage 1986 at scale 1:250 000

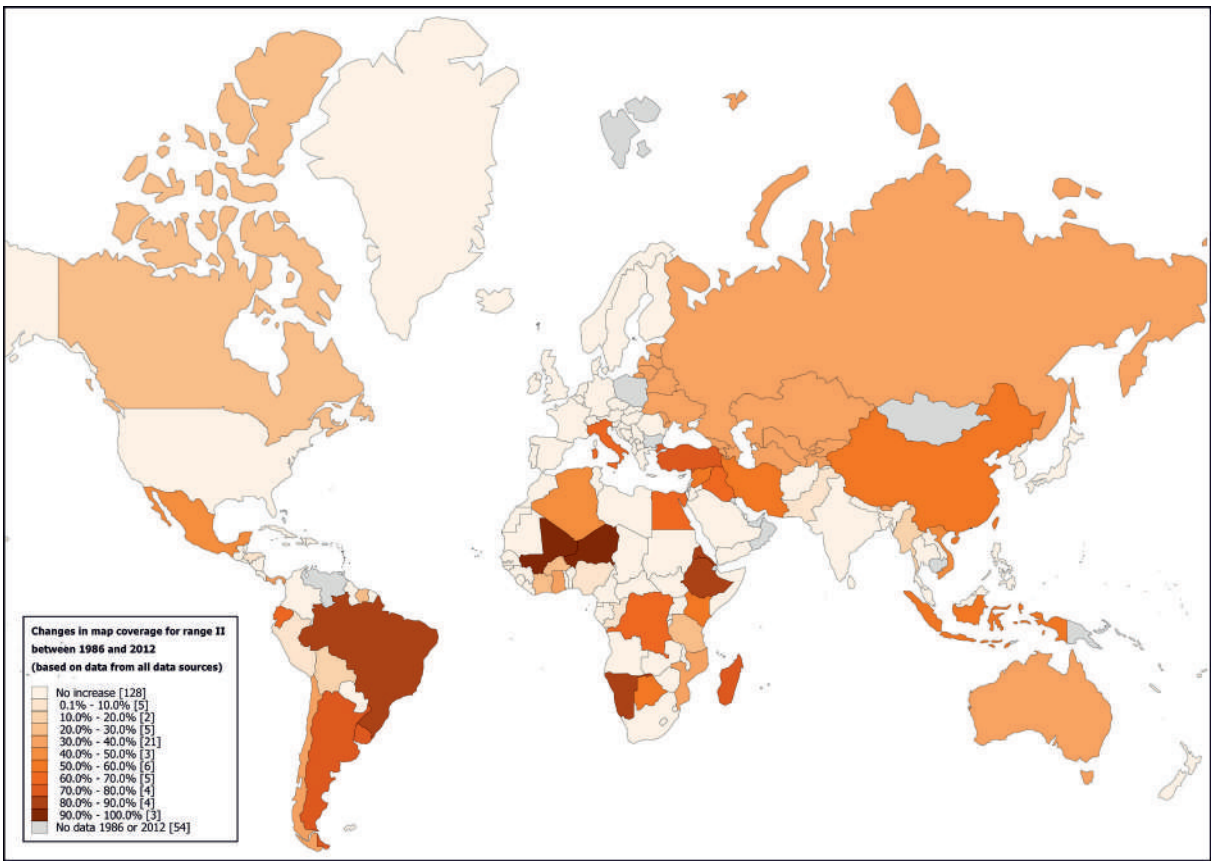


Fig. 14: Change in map coverage between 1986 and 2012 for range II - 1:50,000

This answers question 2 at least in part.

The change map in Fig. 14 indicates where the most relevant changes have occurred between 1986 and 2012: most significantly in Latin America, in Sub-Saharan Africa, but also in China, Mexico, Iran and Turkey, as well as to a somewhat lesser degree in the Russian Federation, in Australia and in Canada.

The other 25 questions characterize the general global infrastructure for provision of map data. Fig. 15 to Fig. 39 give answers to the most relevant questions from 3 to 27 in the listed categories. They are summarized as follows:

1) Restricted access to data: While there are no restrictions in the Americas, in Europe, in most of Africa and in Oceania, restrictions to the data for the public exist in the Russian Federation and in most parts of Asia (e.g. China, Iran, Saudi Arabia). See Fig. 15.
2) Sale of data versus free of charge availability of data: In the Americas data are generally free of charge. They are sold to the public or to governmental users in Europe, Africa, Asia and Australia. See Fig. 16.
3) With the exception of most parts of Europe, South Africa, Iran, Saudi Arabia most other countries use satellite imagery for national data updating. See Fig. 19.
4) Crowd sourcing is only introduced in the USA, France, Spain, Poland and Finland. Fig. 20.
5) While mapping in the Russian Federation, in China, in Mexico and in France is done in-house by the national mapping agencies, in the USA, Canada Brazil, South Africa,

Australia, Japan and Iran mapping is also done by outsourcing or exclusively by outsourcing, like in Saudi Arabia and Namibia. See Fig. 21.

6) Almost all countries use ortho imaging as additional source to supplement mapping. See Fig. 26.
7) Interest in 3D mapping is prevalent in Europe, China, the Russian Federation, Australia and Brazil, while in North America, Scandinavia and South Africa governmental mapping agencies have no direct interest see Fig. 27.
8) National cadastral coverage is lacking in the Americas and in Saudi Arabia. See Fig. 28.
9) With the exception of Great Britain all national mapping agencies are funded by government. See Fig. 33.
10) Few countries have answered budgetary details. But for those, which answered, the funding per area is highest in Britain, France, the Scandinavian countries and in Japan. See Fig. 34.
11) The number of mapping staff per area is highest in China, Japan, Europe, Mexico and Kenya. See Fig. 35.
12) The delivery of map data via web services is practiced in North America, in most of Europe, in China and in South Africa. See Fig. 37.

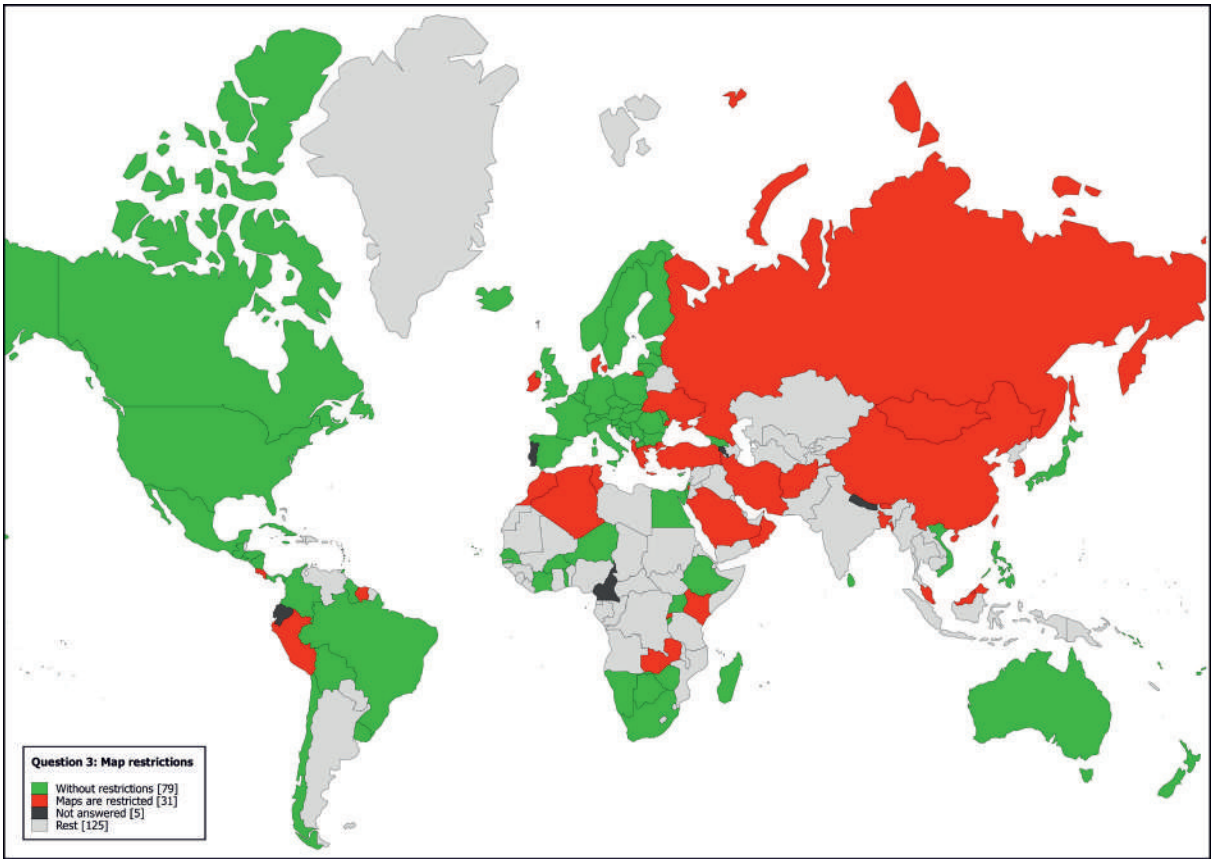


Fig. 15: Question 3. Restricted access or limited circulation to maps and/or data

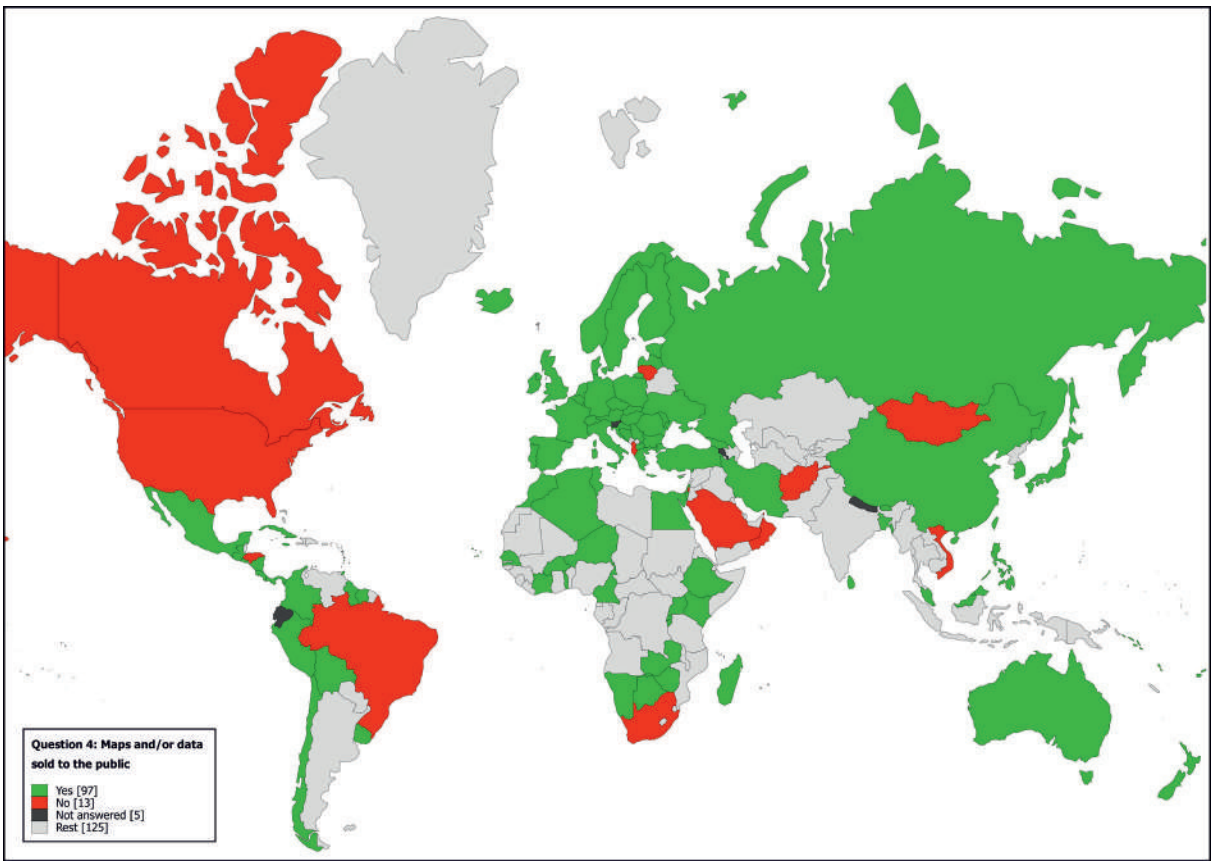


Fig. 16: Question 4. Maps and/or digital data sold to the public or data free of charge

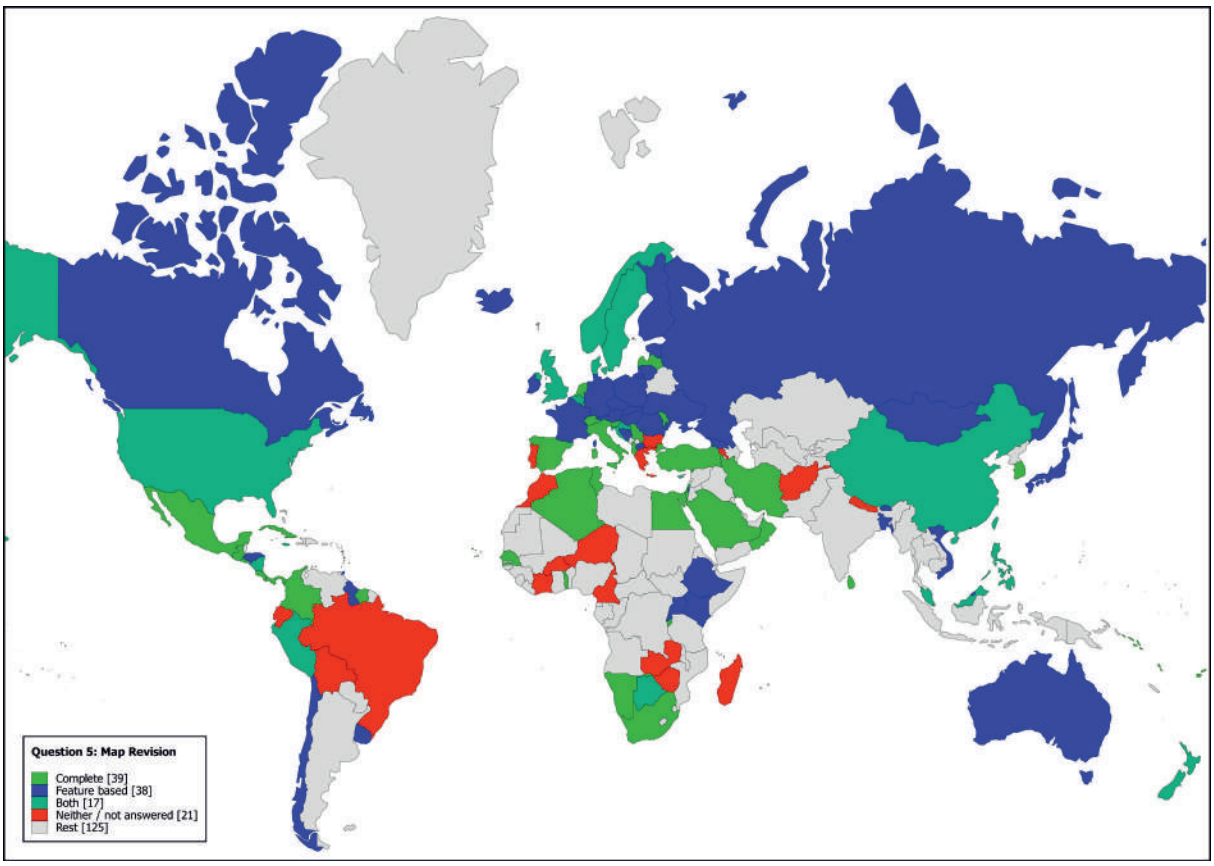


Fig. 17: Question 5. Cycle of map and data revision by complete mapping, i.e. revision of a national series or mapping of changed features

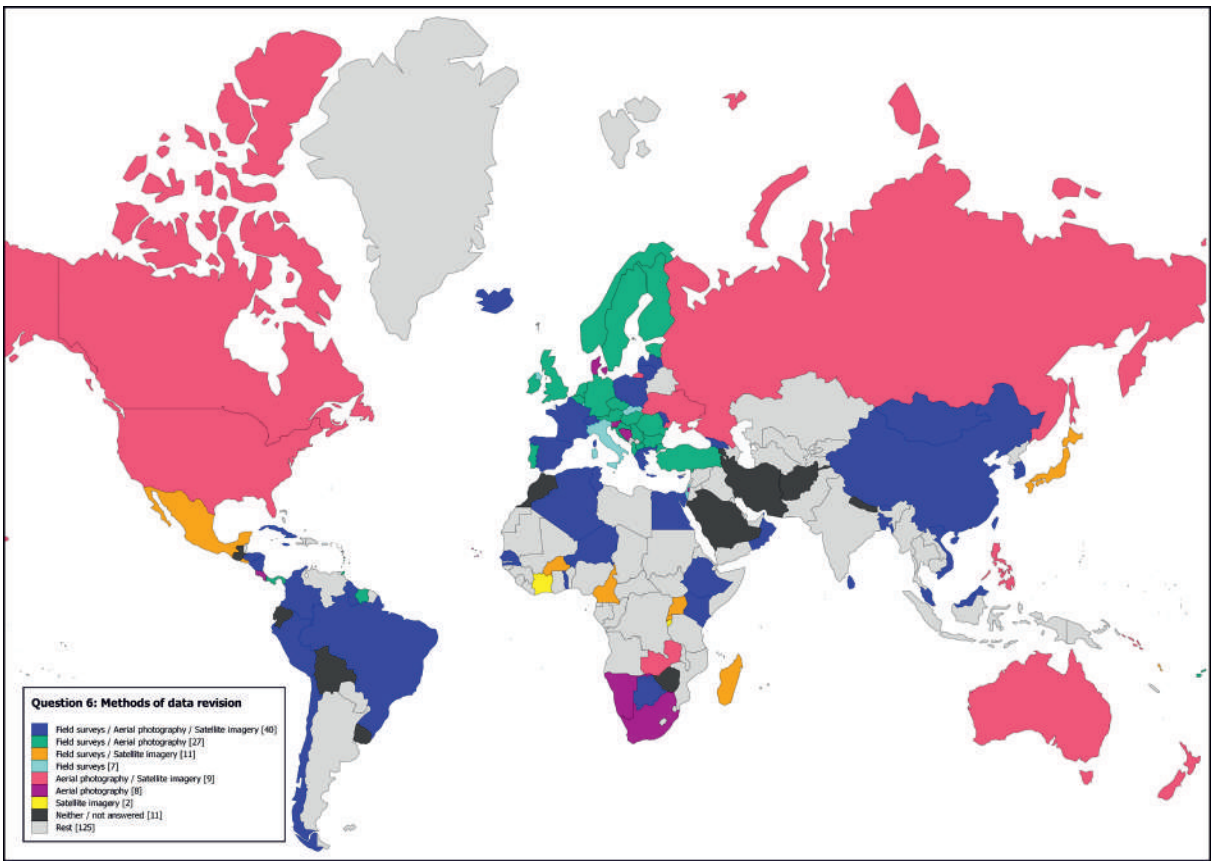


Fig. 18: Question 6. Methods of national data revision and map updating

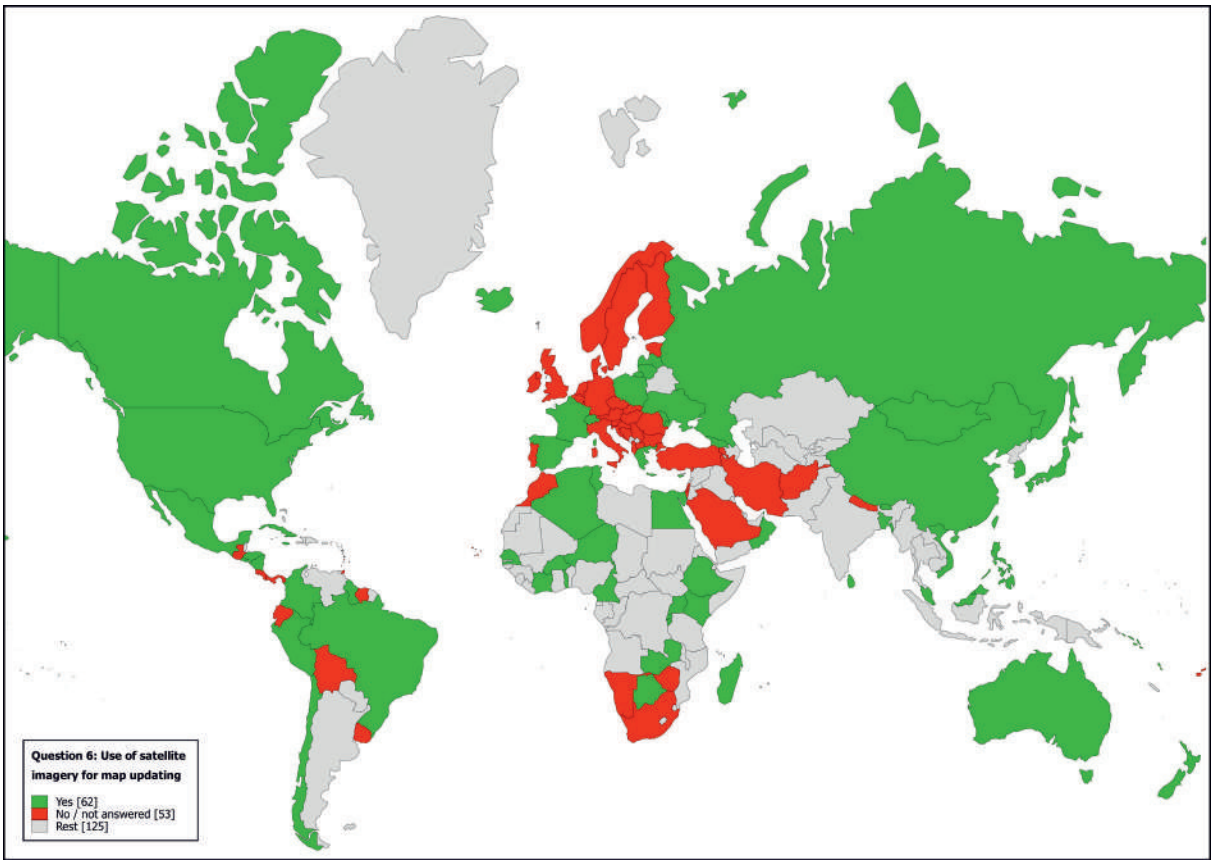


Fig. 19: Question 6. Use of satellite imagery for national data revision and map updating

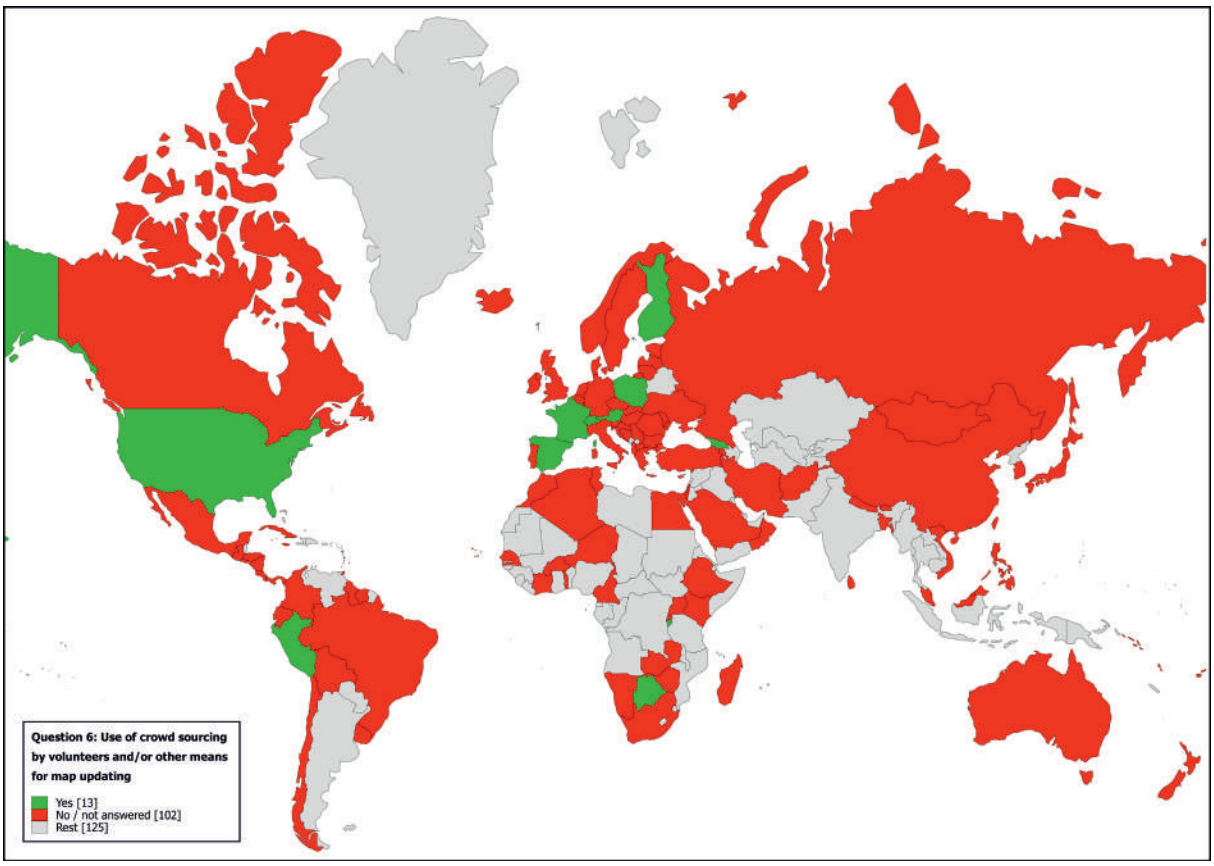


Fig. 20: Question 6. Use of crowd sourcing for national data revision and map updating

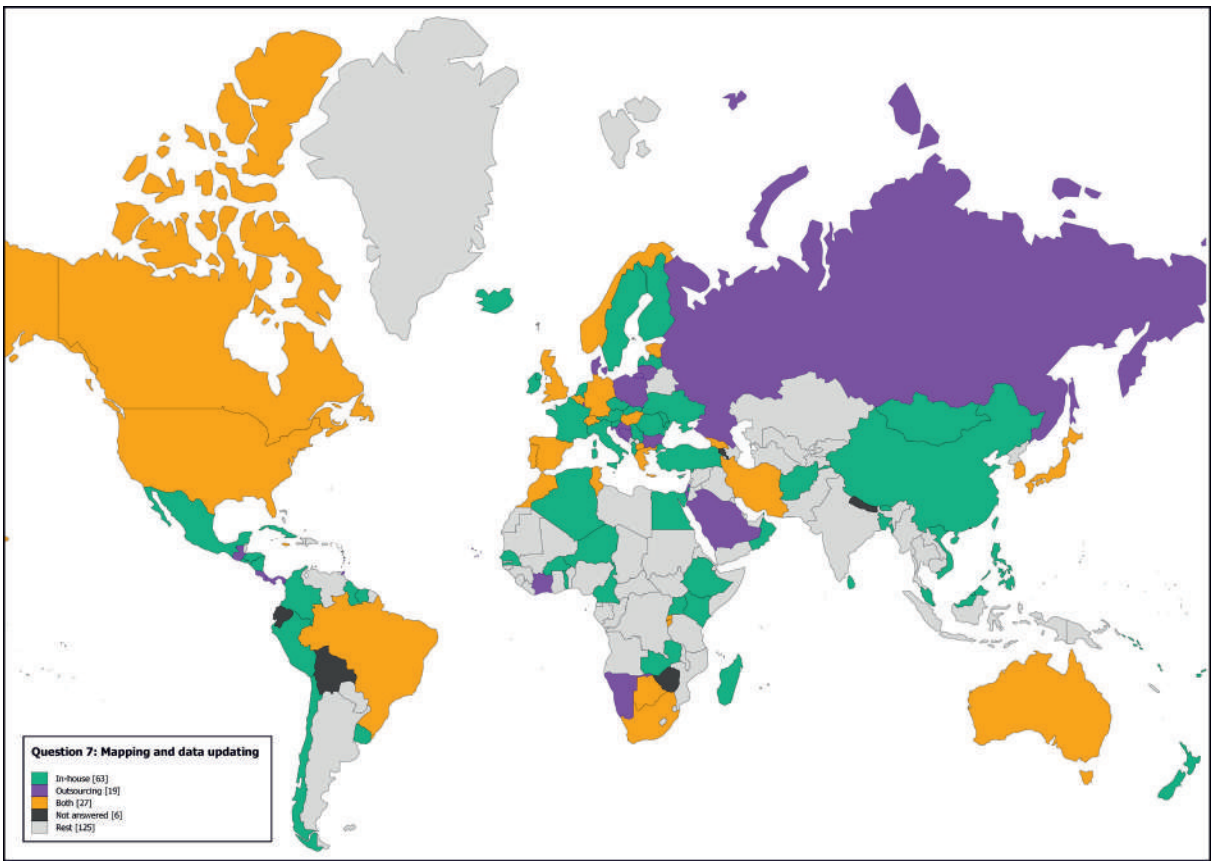


Fig. 21: Question 7. Mapping and map updating done in-house or by outsourcing

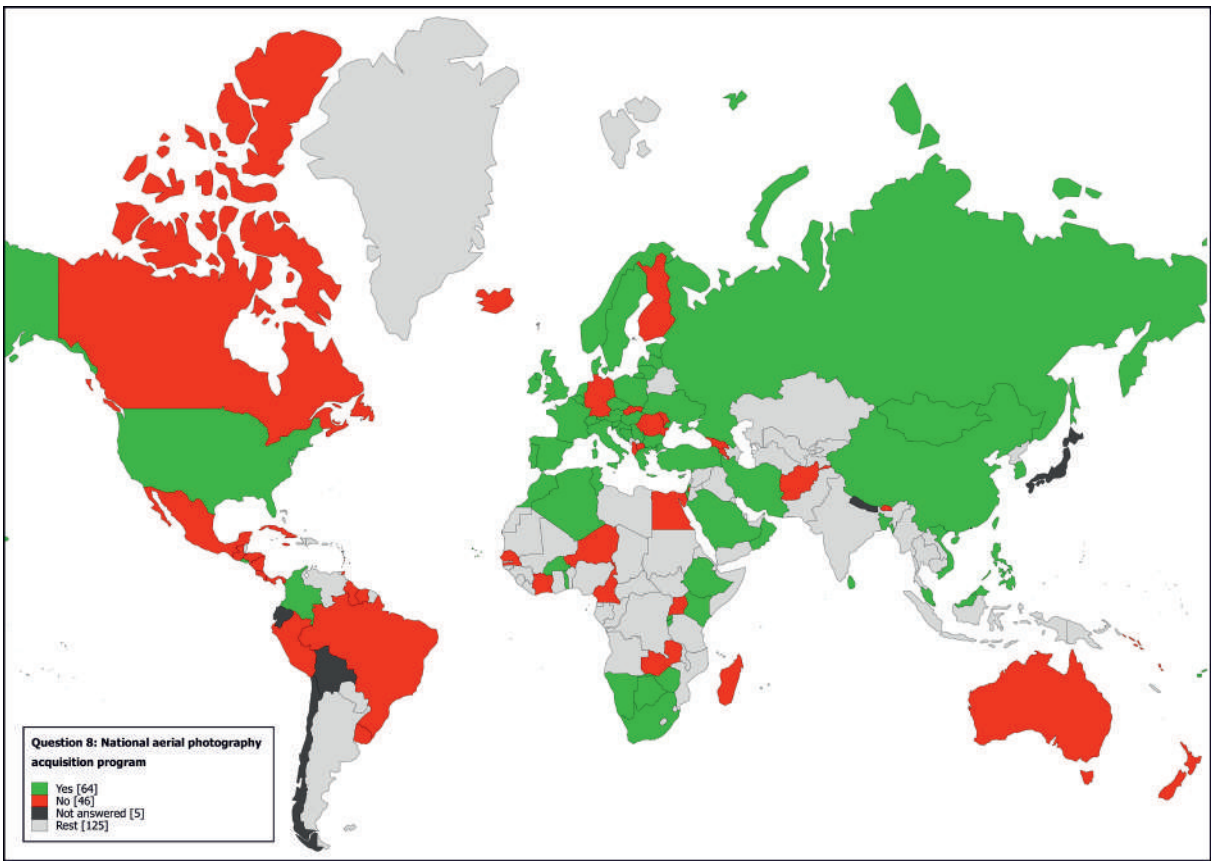


Fig. 22: Question 8: National aerial photography acquisition program

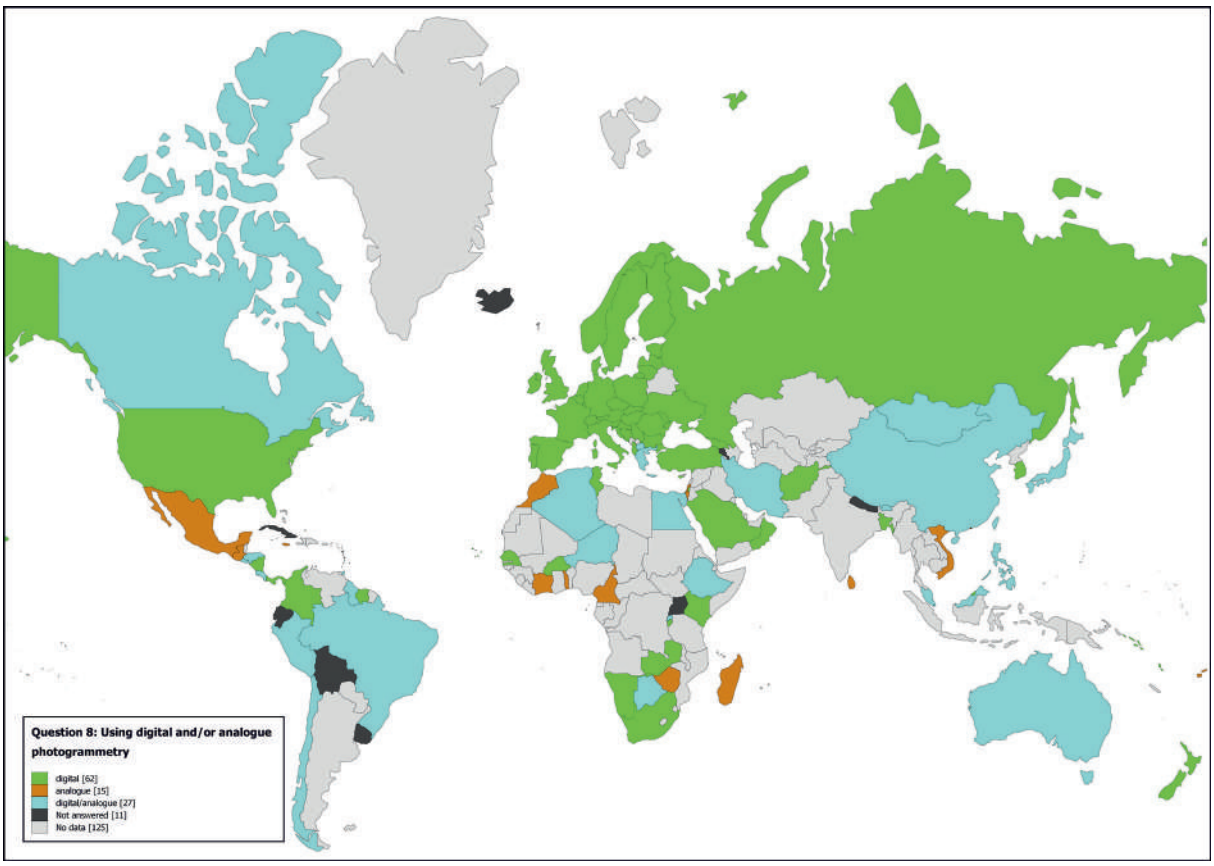


Fig. 23: Question 8. Using digital and/or analogue photogrammetry

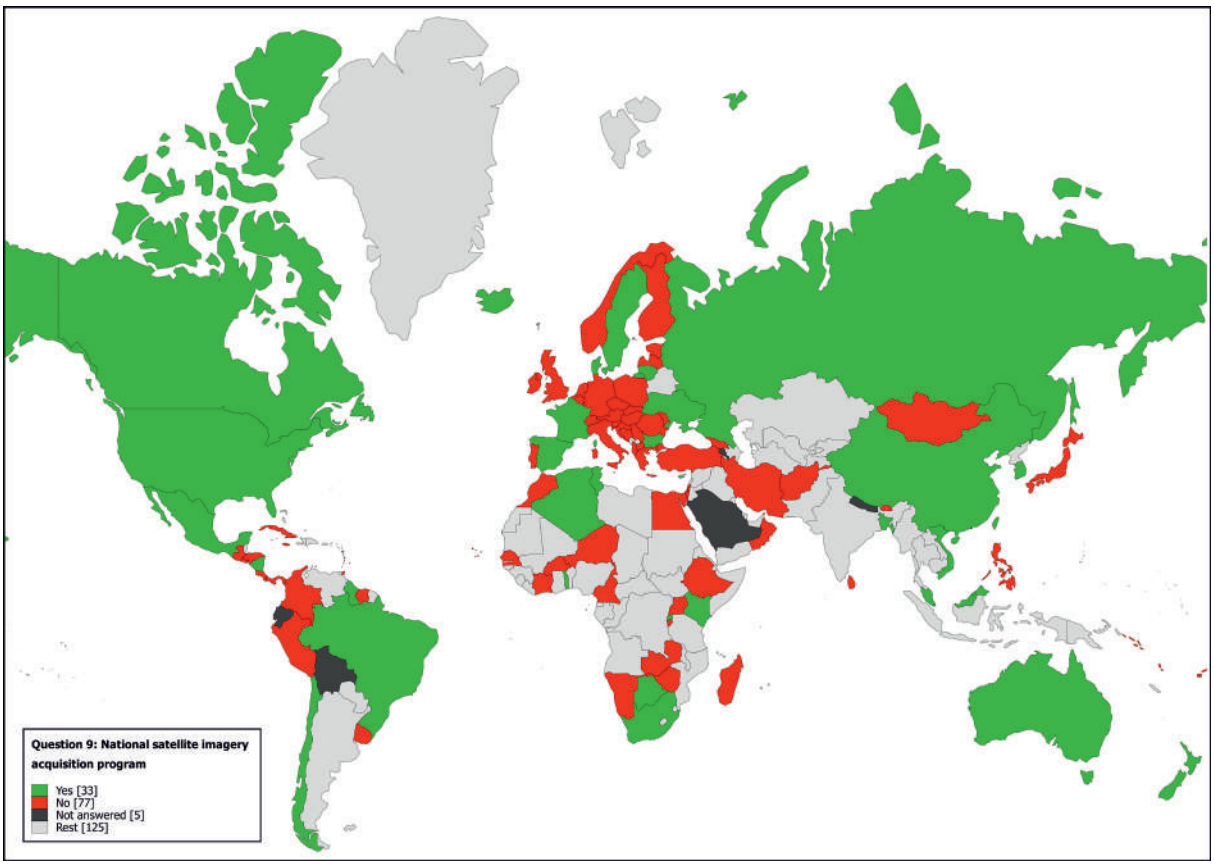


Fig. 24: Question 9: National satellite imagery acquisition program

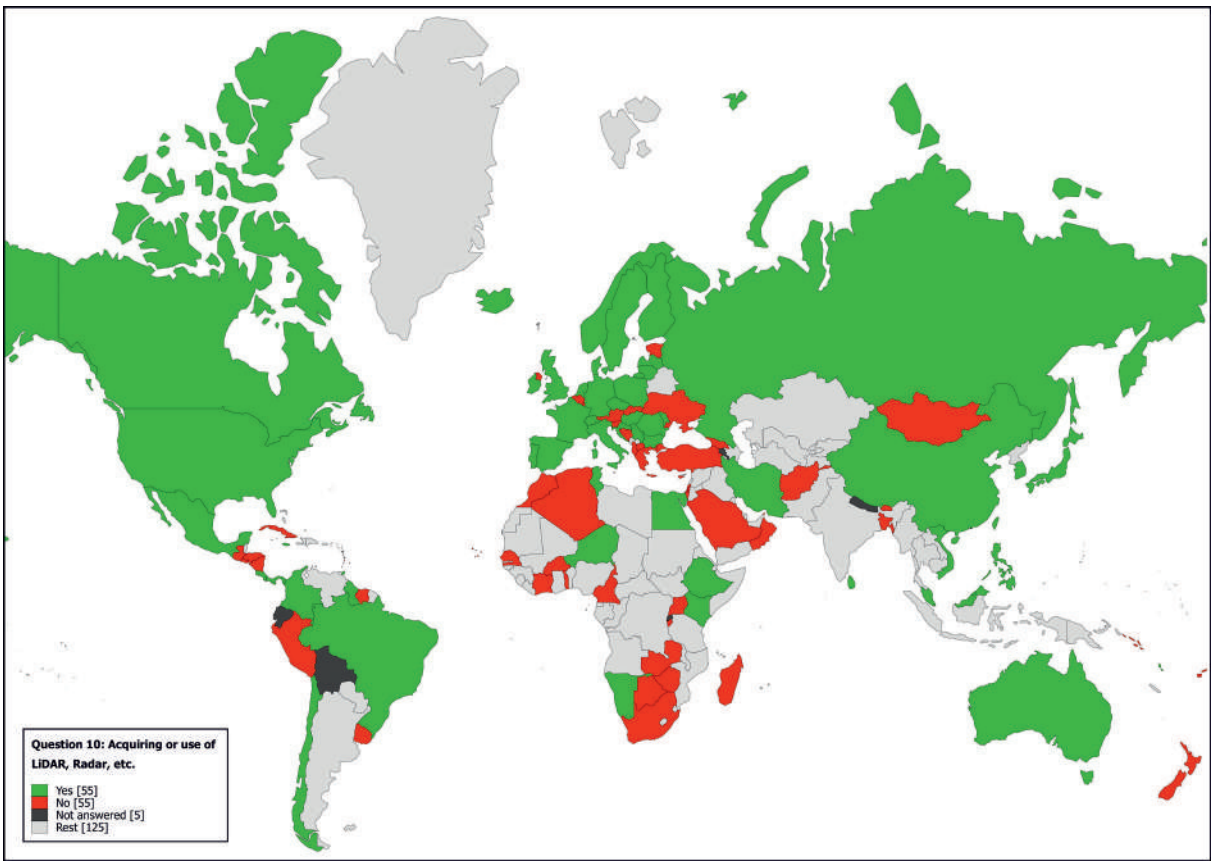


Fig. 25: Question 10. Acquiring and/or using other imagery types (such as LiDAR, RADAR, etc.)

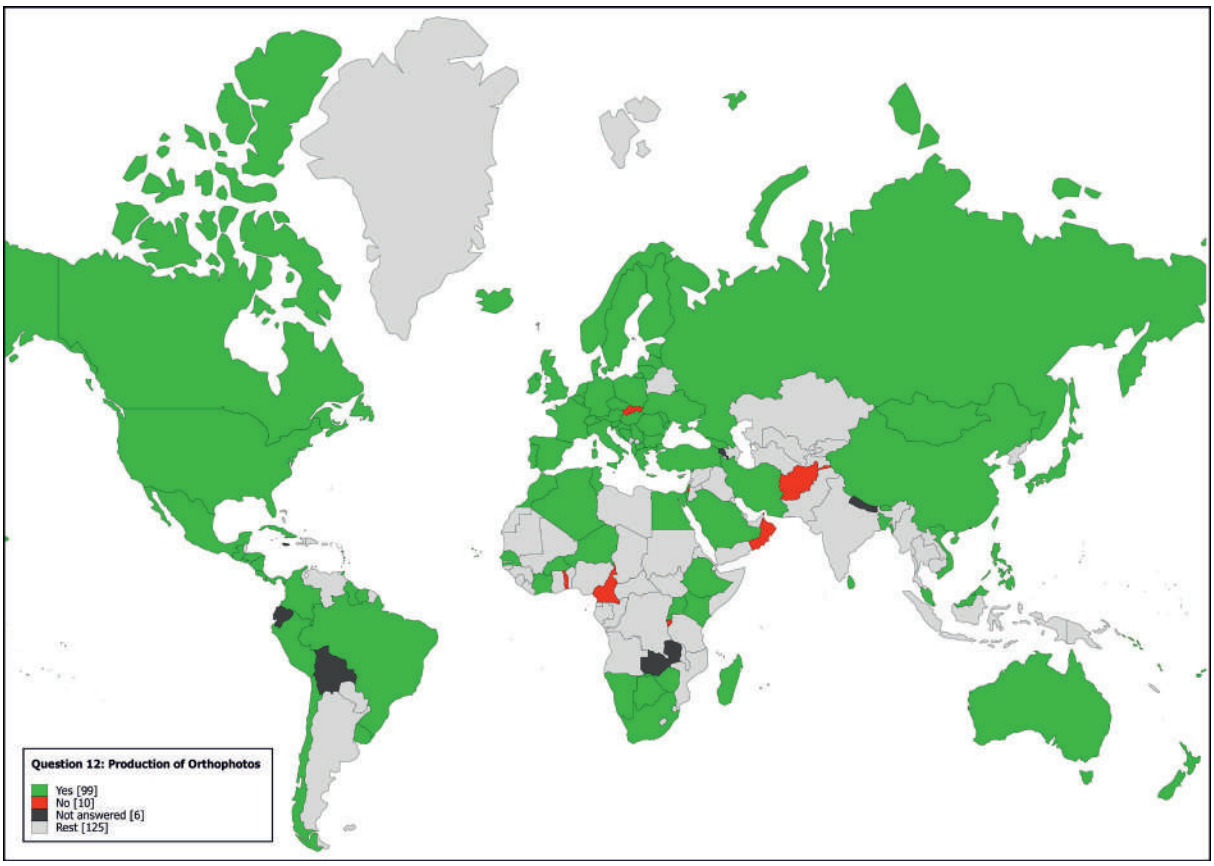


Fig. 26: Question 12. Production of orthophotos and orthophotomaps

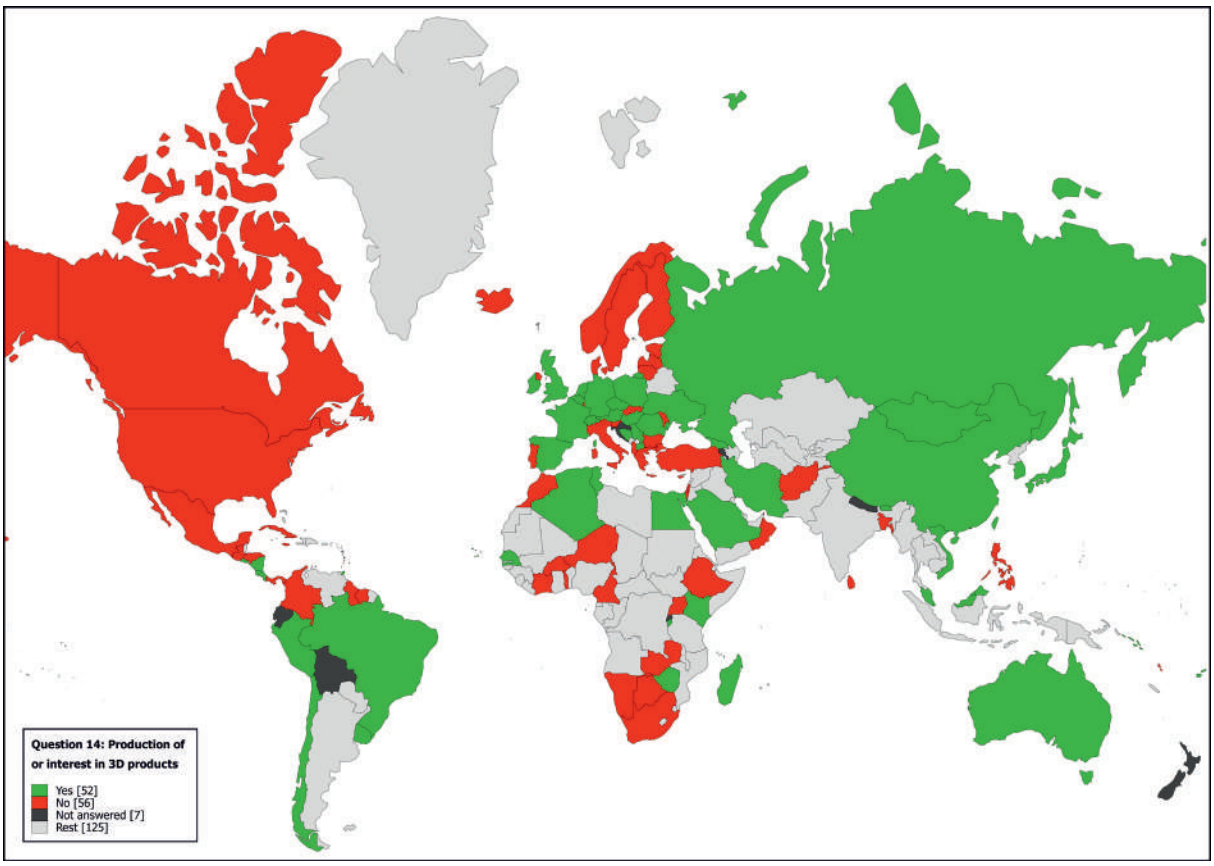


Fig. 27: Question 14. Production or intention to produce, 3D urban and rural landscape models and/or product visualization

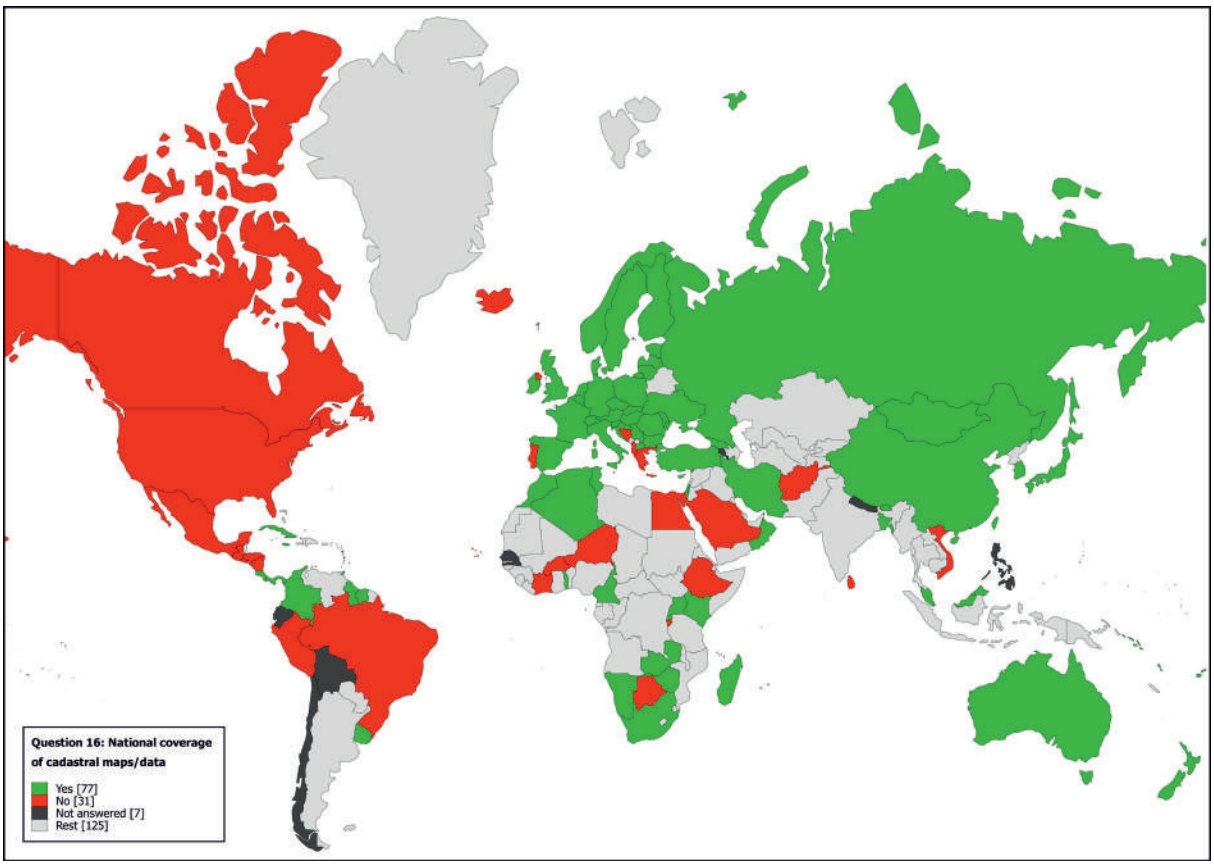


Fig. 28: Question 16. National coverage of cadastral maps and/or data available

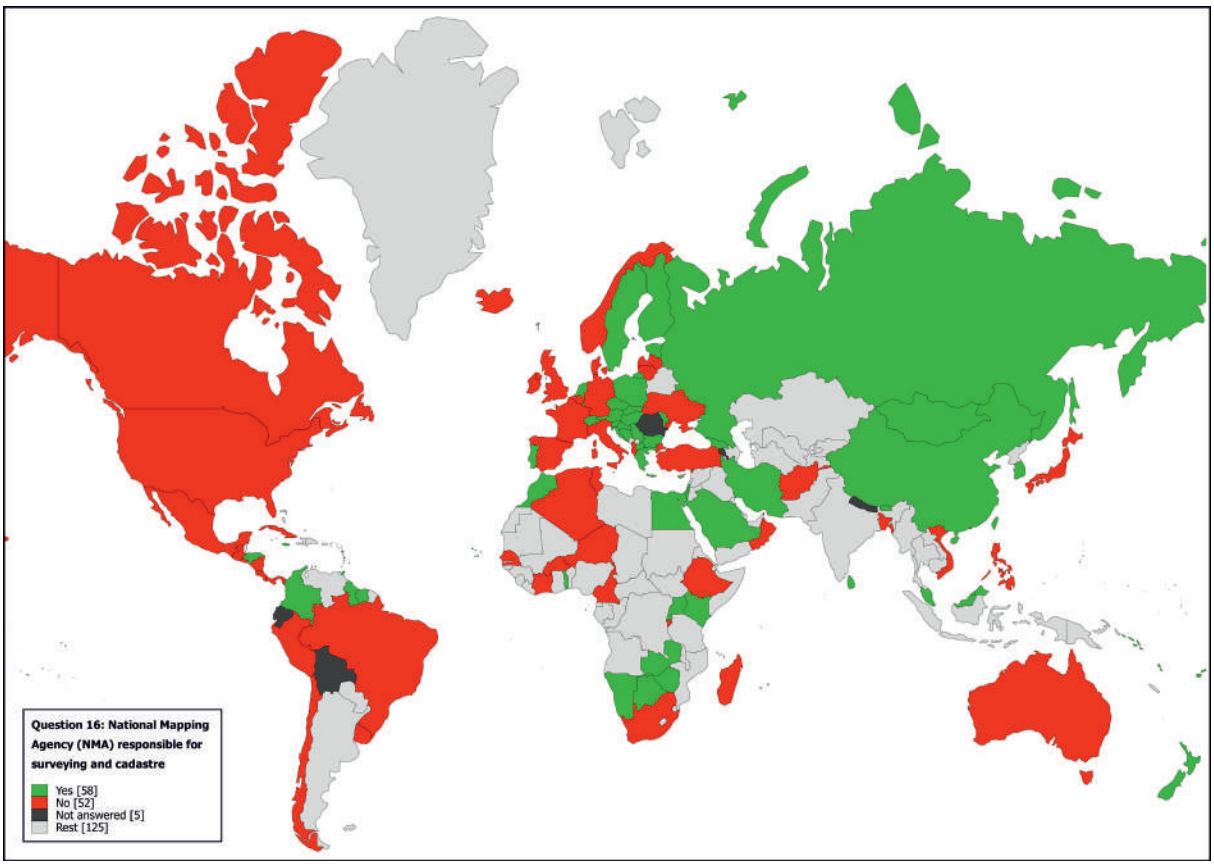


Fig. 29: Question 16. National Mapping Agency (NMA) responsible for surveying and/or land titles and cadastre

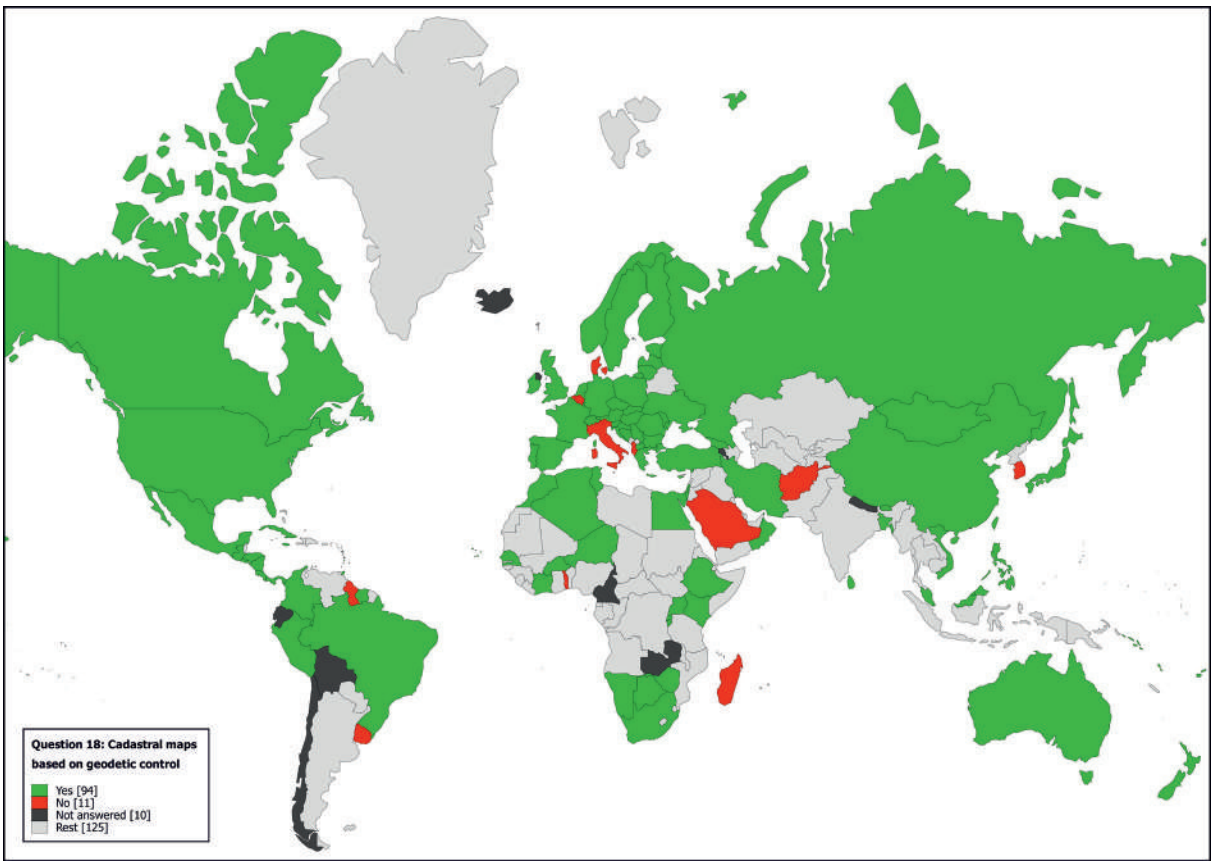


Fig. 30: Question 18. Cadastral maps based on geodetic control

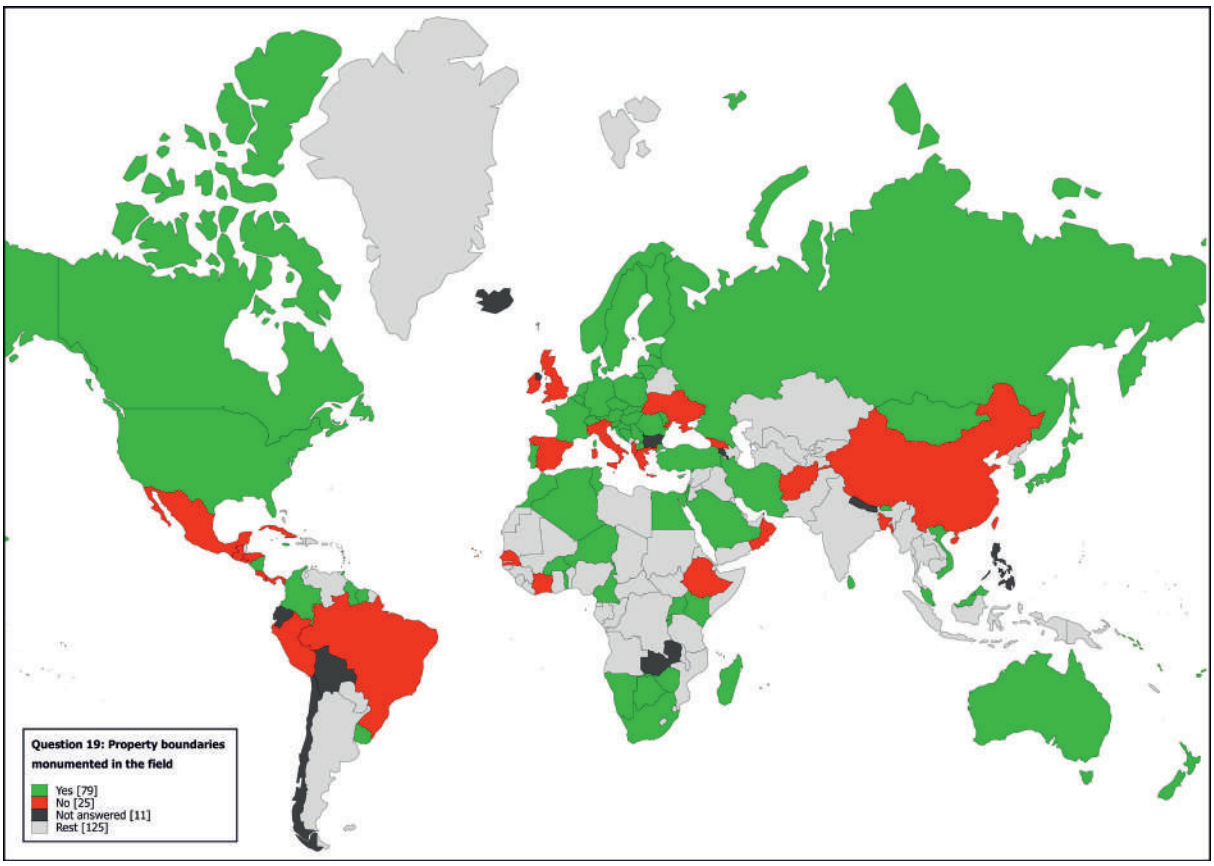


Fig. 31: Question 19. Property boundaries monumented in the field

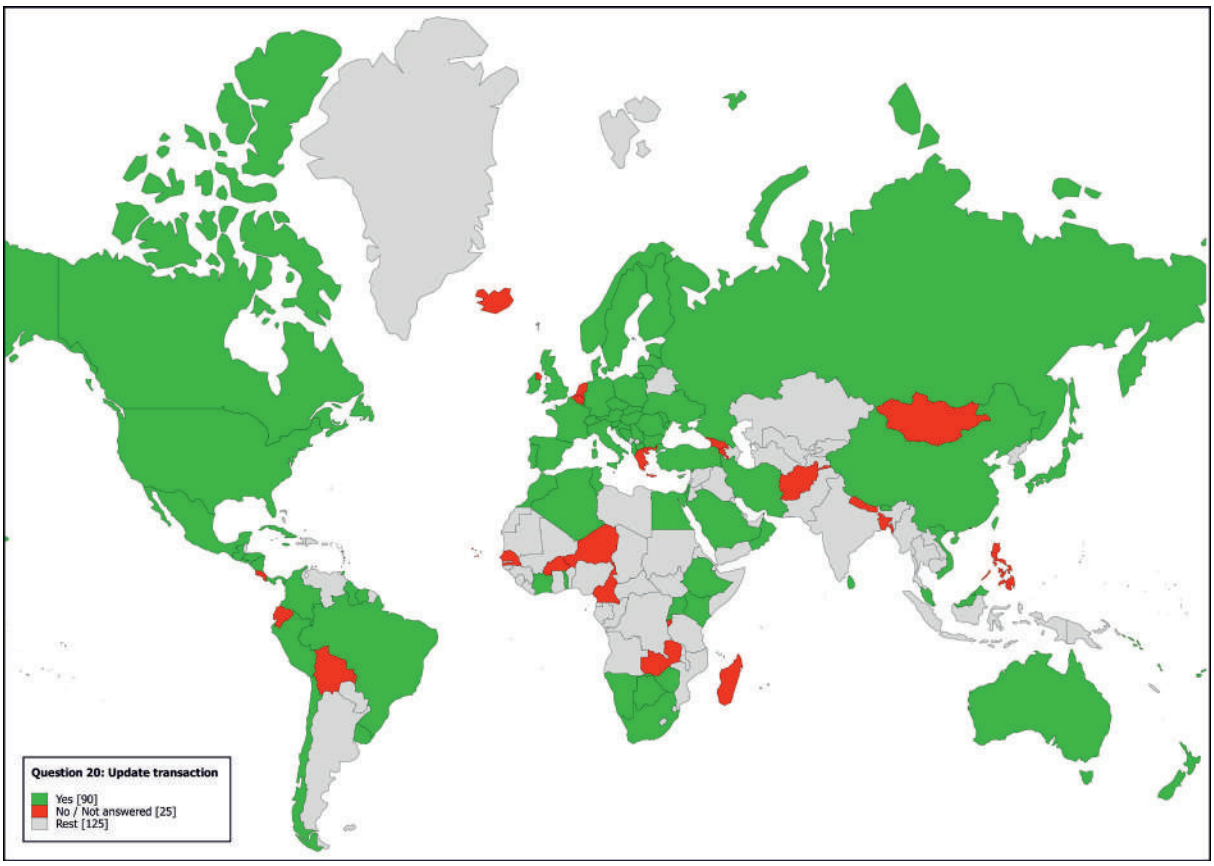


Fig. 32: Question 20. Update transaction of property maps and/or data

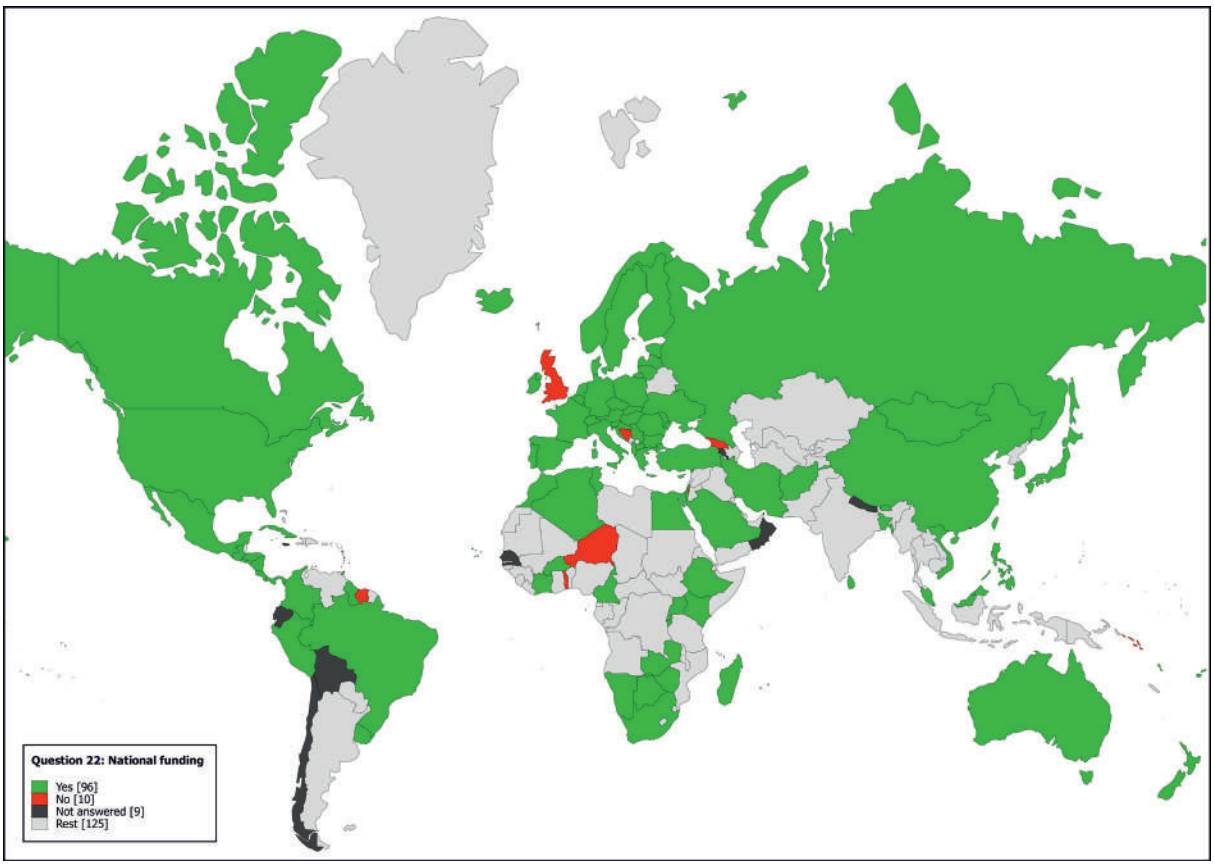


Fig. 33: Question 22. National topographic mapping, imagery acquisition, surveying and cadastral programs funded by your national Government

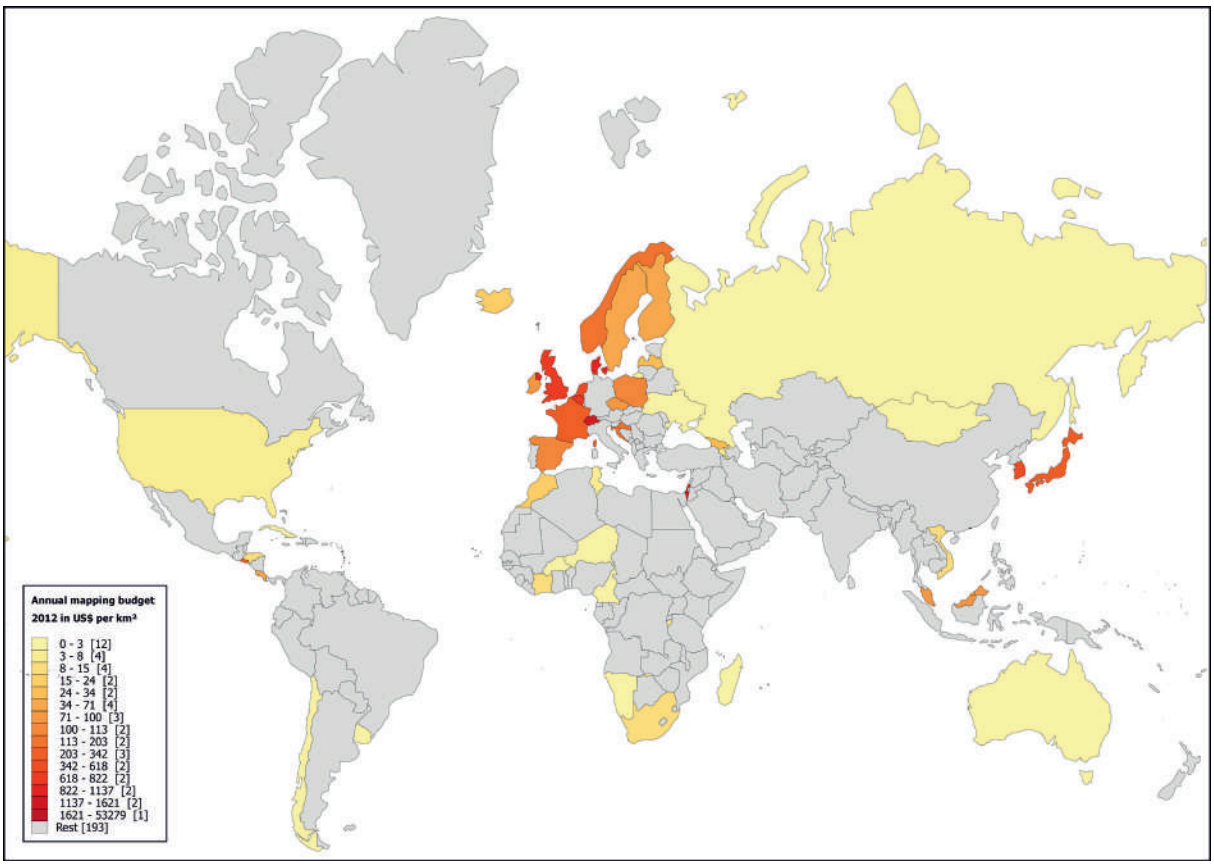


Fig. 34: Question 23. Annual mapping budget of the National Mapping Organization converted to million US$ per square kilometer of the country area

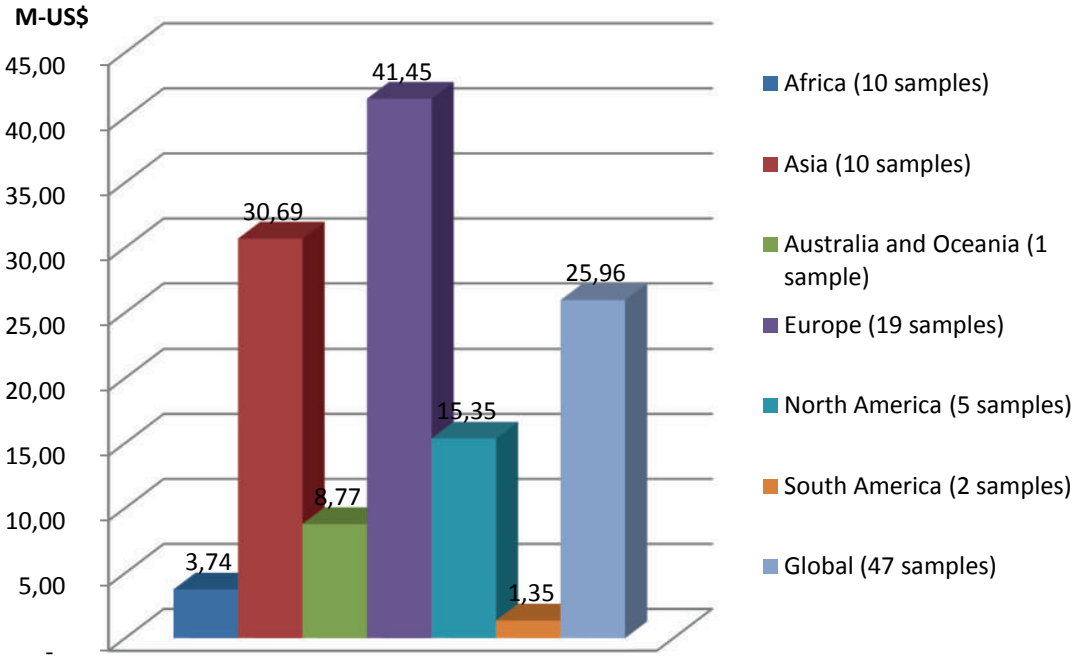


Chart 5: Question 23. Average annual budget 2012 per continental region converted to million-US$

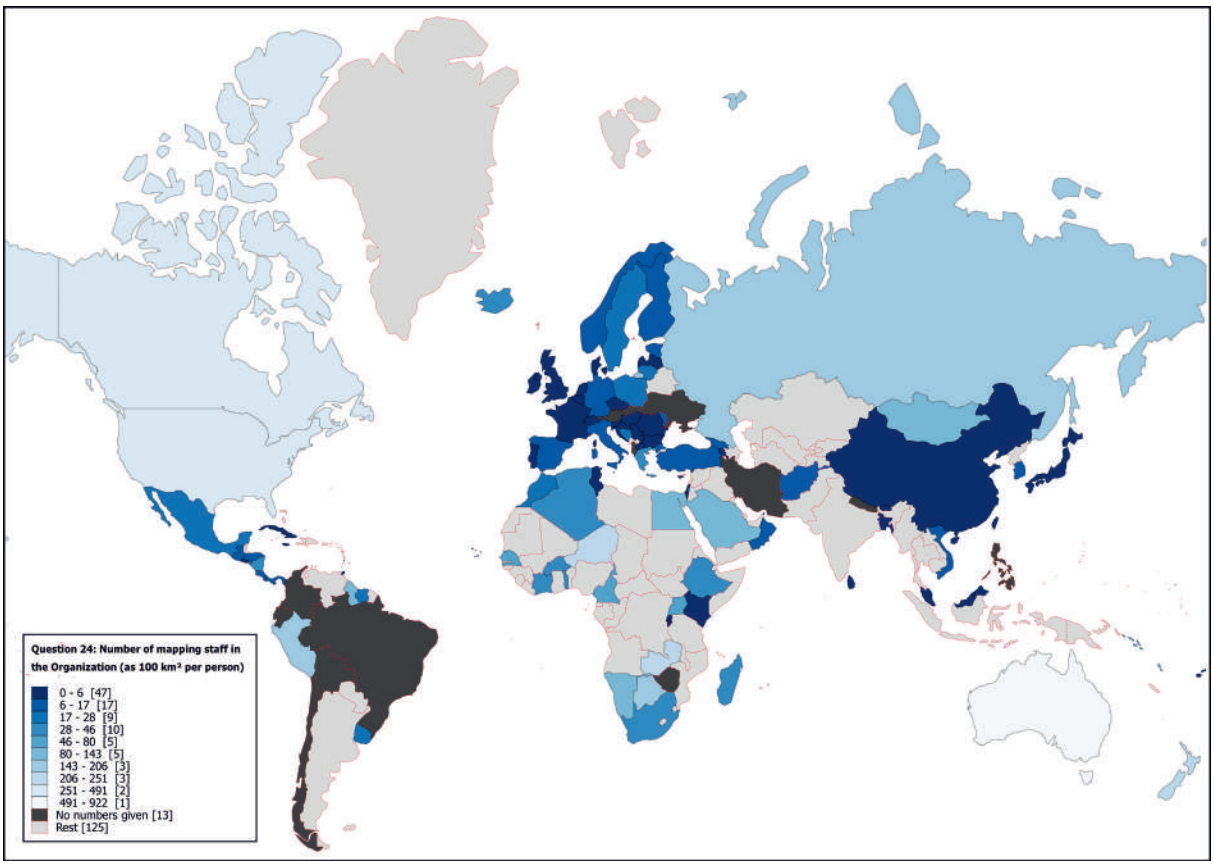


Fig. 35: Question 24. Number of mapping staff in the Organization as hundreds of square kilometers of country area per person

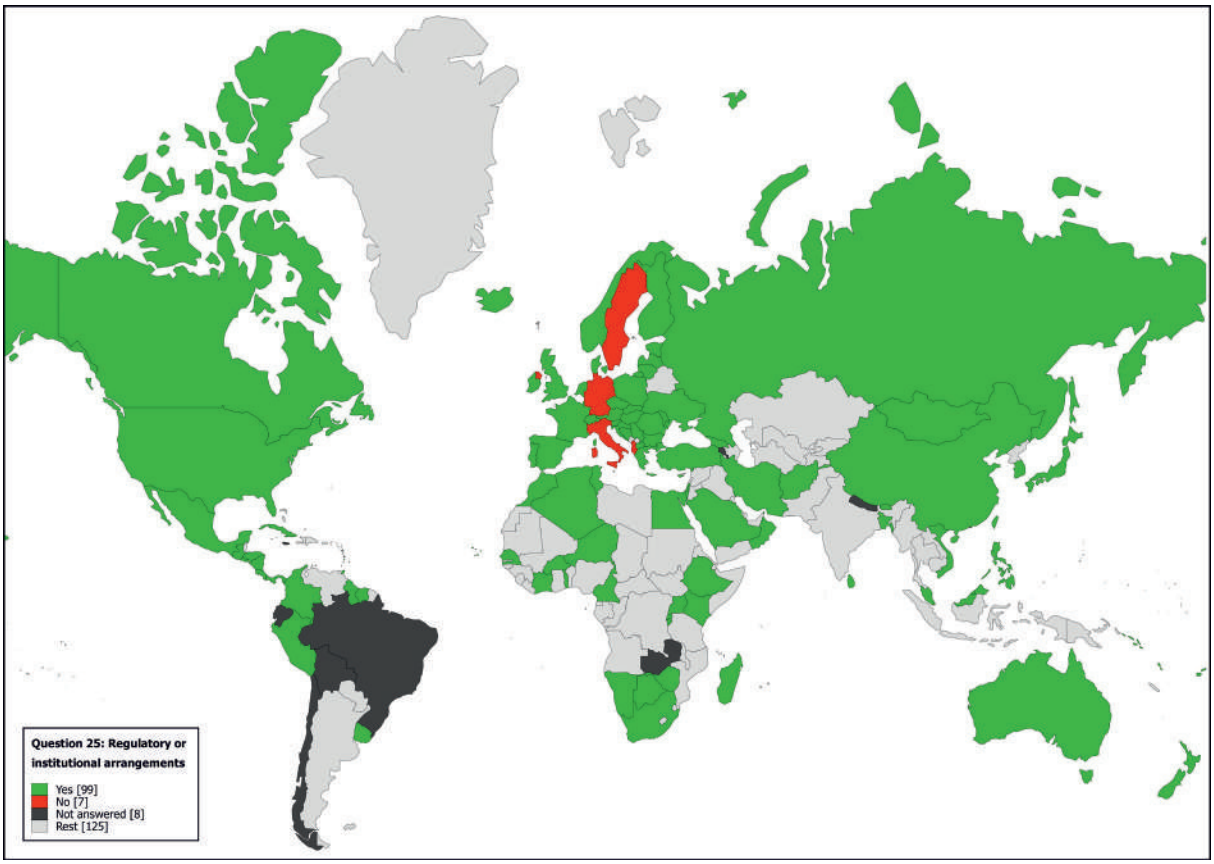


Fig. 36: Question 25. Regulatory or institutional arrangements mandating the organization to fulfil its role as the lead mapping agency

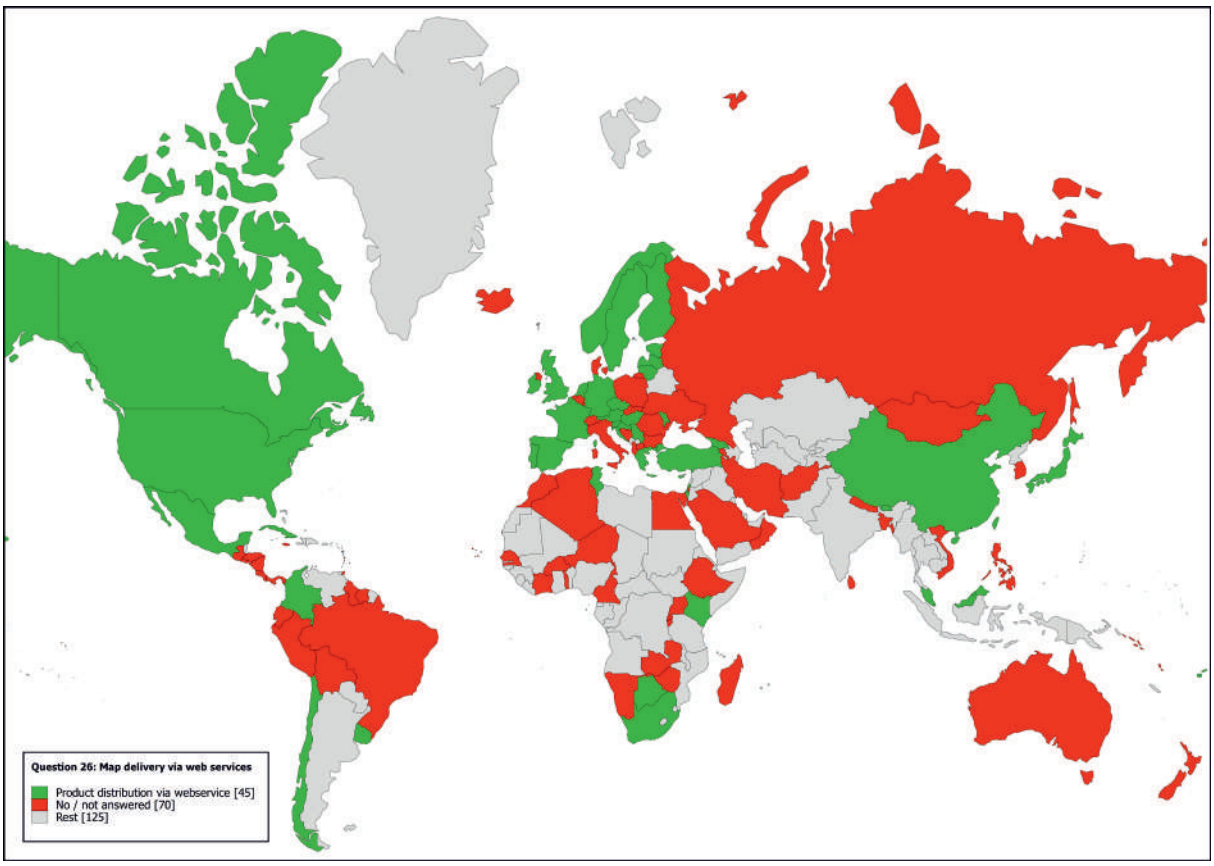


Fig. 37: Question 26. Delivery of different map and data products via web services

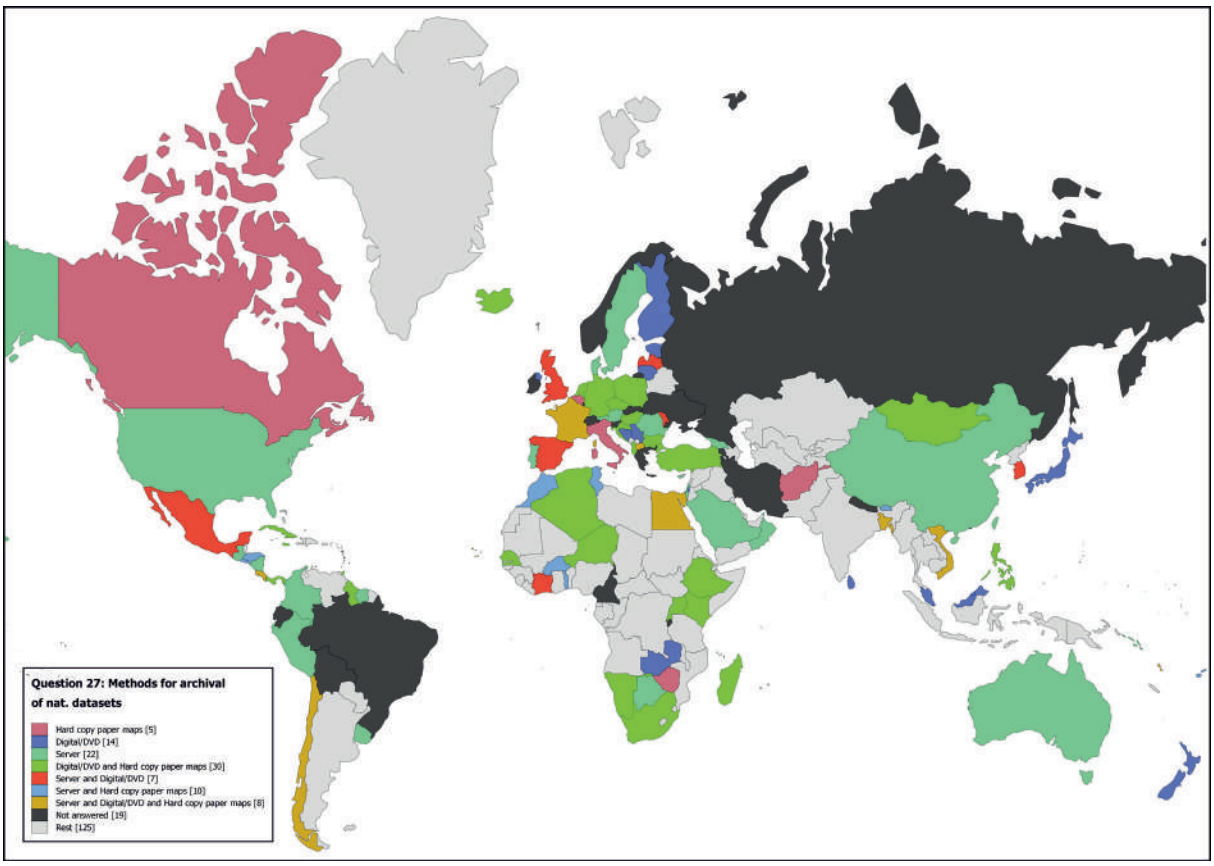


Fig. 38: Question 27. Methods of archival for the national data sets

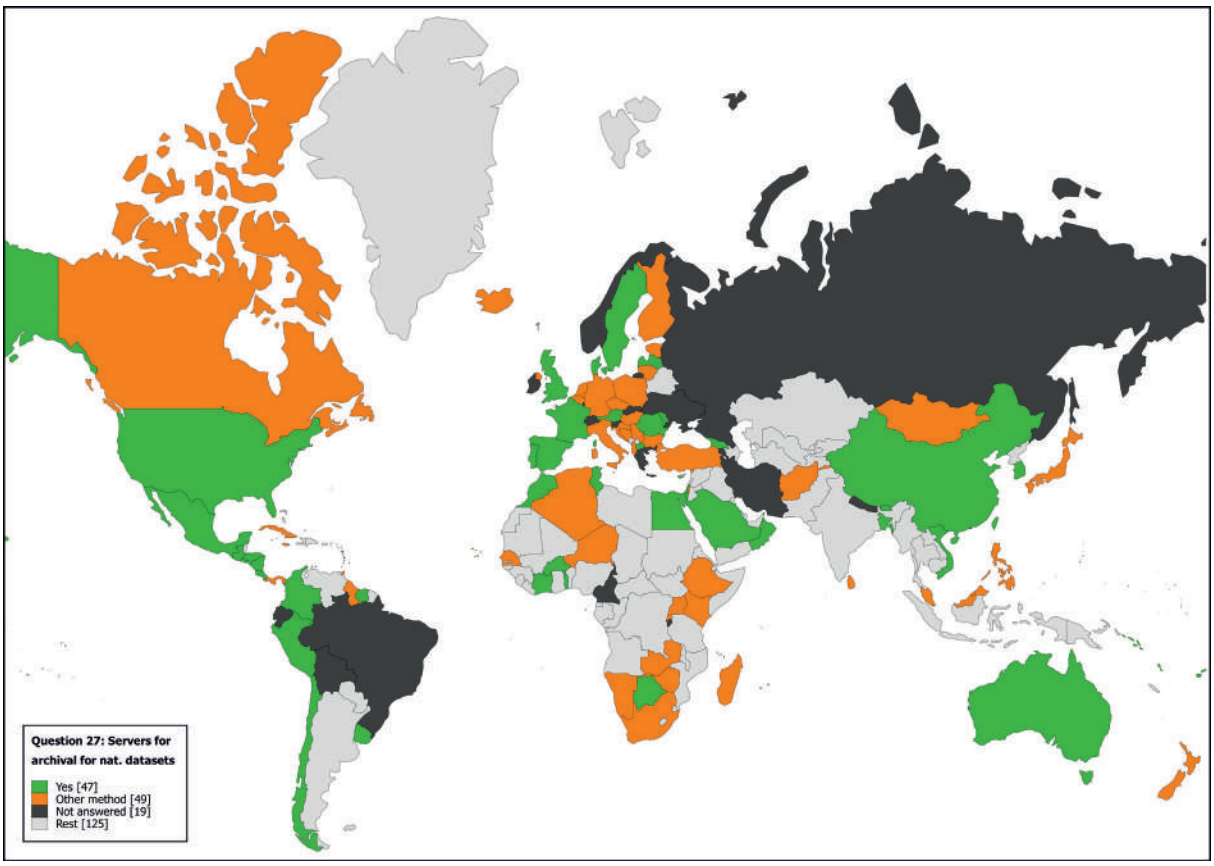


Fig. 39: Question 27. Using servers/databases as method of archival for the national data sets

5 Mapping Contributions by Private Industry

As has been demonstrated, official and authoritative mapping by governments provides a reliable geospatial infrastructure, which is used for many public and private applications, but which is costly, difficult and slow to maintain. For that reason private enterprises have succeeded to launch several initiatives to provide faster update solutions in areas, which require fast update solutions. These are based on different cost and accuracy models for specific applications, which require fast updates. These applications do not replace official authoritative cartography, but they supplement it, as all such efforts utilize official cartographic products as a base to start their value added operations.

5.1 Google

Google´s prime aim is to provide a location based information system for uses of the public. What the general user wants is quick orientation about how to locate a specific object, such as a landmark, a store, a restaurant or a service provider and how to drive to it.

Geometric accuracy within the context of the neighborhood topography is of lesser importance than the addressability and the access by roads or pathways. In general, business advertising provides for the revenue to establish and to maintain the system.

Google Inc. operates by different projects, of which the following are the most important from the cartographic point of view.

5.1.1 Google Earth

Existing orthophotography coverage with ground sample distances between 0.1m and 0.5m as well as high resolution satellite imagery coverage with ground sample distances (GSD) between 0.5m to 2m and beyond provide the geometric background image information, which can be interpreted by the user with respect to the searched objects, such as buildings, roads, vegetation, water surfaces. While ortho images have a high geometric accuracy related to ground features commensurate with the GSD, this is not so for building tops and tree tops. Geometric accuracy even deteriorates more for high resolution satellite imagery, since most of these images have been acquired with inclinations with respect to the vertical, unless stereo imaging permitted the generation of ortho imagery. The coverage is global for all land areas.

Nevertheless, despite some of these shortcomings with respect to official cartography, Google Earth can easily satisfy the geolocation demands for the uses Google Earth has been designed for.

5.1.2 Google Maps

Google Maps is a product usually derived, wherever possible, from authoritative cartography. It has been designed to supplement Google Earth with a cartographic output containing place names, road names and building addresses. It serves the ideal function of superimposing images with line graphics. Even though Google Maps may be derived from authoritative cartography, the feature content is much less elaborate and reduced to the intended geolocation function. The 3 models for creating Google Maps are shown in Fig. 40: a) relying on authoritative data in North America, Europe, Australia as "Google Ground Truth", b) Map Maker outsourced, leaving the initiative of mapping using Google Earth to other companies (Africa, Middle East, India) and c) "Video Rental" model offering Google Earth imagery to other countries for mapping use (Russia, China).

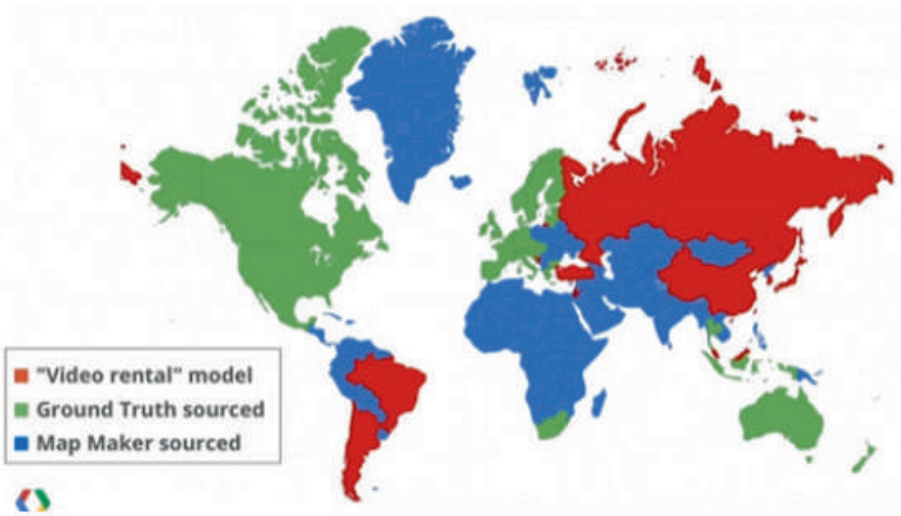


Fig. 40: Google Maps

5.1.3 Google Street Map

Google Street Map has been developed as a tool to image buildings and streets with street furniture along urban roadways. This is done by vehicle based cameras, located by GNSS

signals. In some communities the imaging of building facades has met resistance by some members of the population, which did not wish to show them to the public on the web. Nevertheless Google has pursued street mapping for the sole reason to update the Google Maps content as an internal operation.

In this manner Google Street Map has proved to be an effective tool to quickly update the Google Maps content for buildings and roads. The update of these features can generally be done much faster than by the regular update intervals for authoritative mapping without a reporting system in operation and without a multitude of fast survey options, rather than by a centralized mapping procedure. For coverage see Fig. 41.

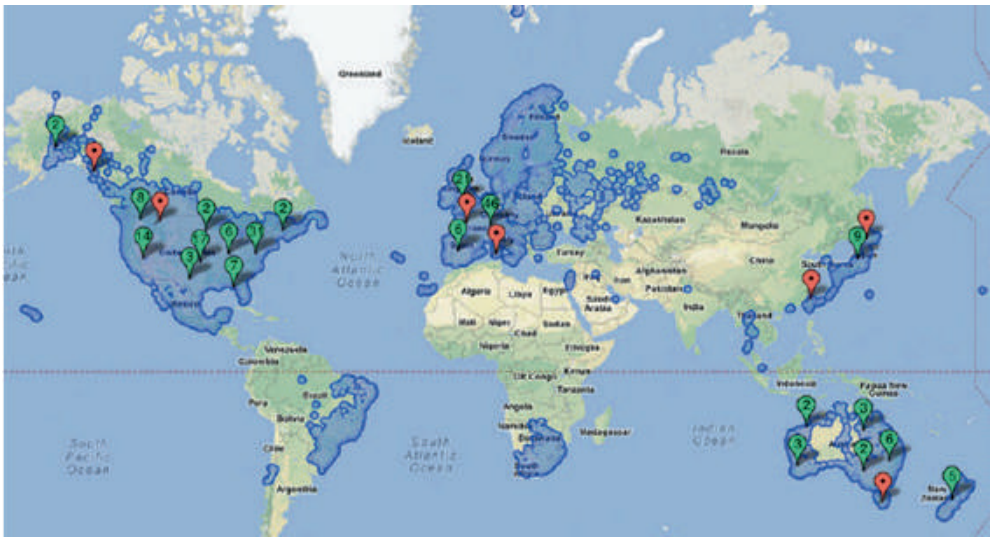


Fig. 41: Google Street Map Coverage

5.1.4 Google Ground Truth

In the attempt not only to update the map content, but also to maintain a high level of geometric accuracy, the Google Ground Truth project has been launched for a number of countries in North America, Europe, Australia and South Africa, in which authoritative cartography has been merged with the results of high tech operations, such as Google Street Map, see Fig. 42.

Fig. 42: Google Ground Truth

As Google regards the progress of these projects as a confidential matter, it is not possible to make a more detailed account of the progress made.

5.2 Microsoft Bingmaps

Microsoft considered Google to be their strongest competitor, while Bingmaps has the same objectives as the Google efforts. Therefore care has been taken to achieve a higher resolution and a more accurate geometry than Google Earth.

This was possible by limiting the area of interest to the continental USA and to Western Europe, where there were no flight restrictions. Furthermore, the imagery used for Bingmaps consisted solely of digital aerial imagery flown by the company owned Vexcel Ultracam cameras.

The coverage of the countryside for the USA and for Western Europe was completed at 30cm GSD, and the urban areas were imaged at 15cm GSD. Whether the originally foreseen updates of every 3 years can be achieved as planned, is still an open issue. See Fig. 43 (a,b,c,d).

There has been a recent announcement that Microsoft turned over Bing Maps technology to UBER.

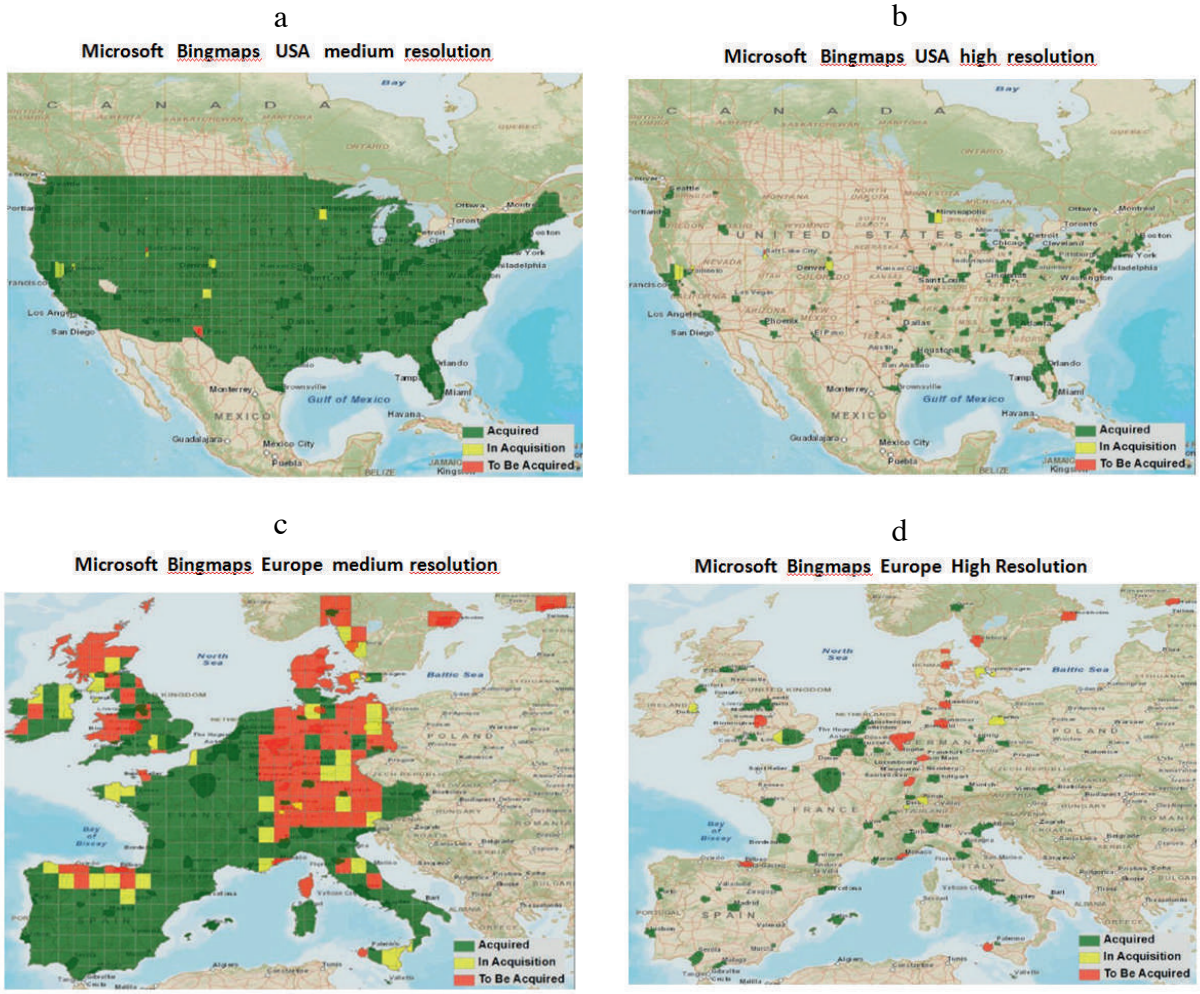


Fig. 43: a,b,c,d Bingmaps

5.3 Yandex

Another approach has been undertaken by Yandex in the Russian Federation, which was also applied in Turkey by the company Yandex.

Yandex has procured high resolution satellite imagery from Digital Globe for the entire territory of the Russian Federation at 0.5m GSD and at 1m GSD. The objects of interest were building blocks, single buildings, roads, creeks. They could be identified and mapped from the images. The geocoding of the mapped information was done by accuracy augmented GNSS code receivers with 2 to 3m accuracy on the ground. In this way Yandex succeeded to generate digital maps for about 300 urban conglomerations in Russia and Turkey.

Yandex, like international car navigation system suppliers, was also interested in car traffic routing, providing real time traffic congestion options for the agglomeration of Moscow.

5.4 HERE

When the Finish company Nokia bought Navteq, the global car navigation system efforts were continued by the subsidiary HERE.

HERE makes car navigation systems based on their own maps for 196 countries of the world, 116 countries of which have voice guided navigation and 44 countries of which with live traffic services.

Of interest are roads and points of interest. This also includes unidirectional restrictions of traffic flows.

In Europe 15% of the map´s content is updated every year, modifying or adding 1.1M km of roads, creating 700 000 new points of interest and adding 600 000 speed cameras.

In the Russian Federation 800 000 km of roads change after 6 months, and so do 120 000 street names, 22 000 turn restrictions, 3400 one way streets, 38 000 speed limits and 8700 directional street signs. See Fig. 44:

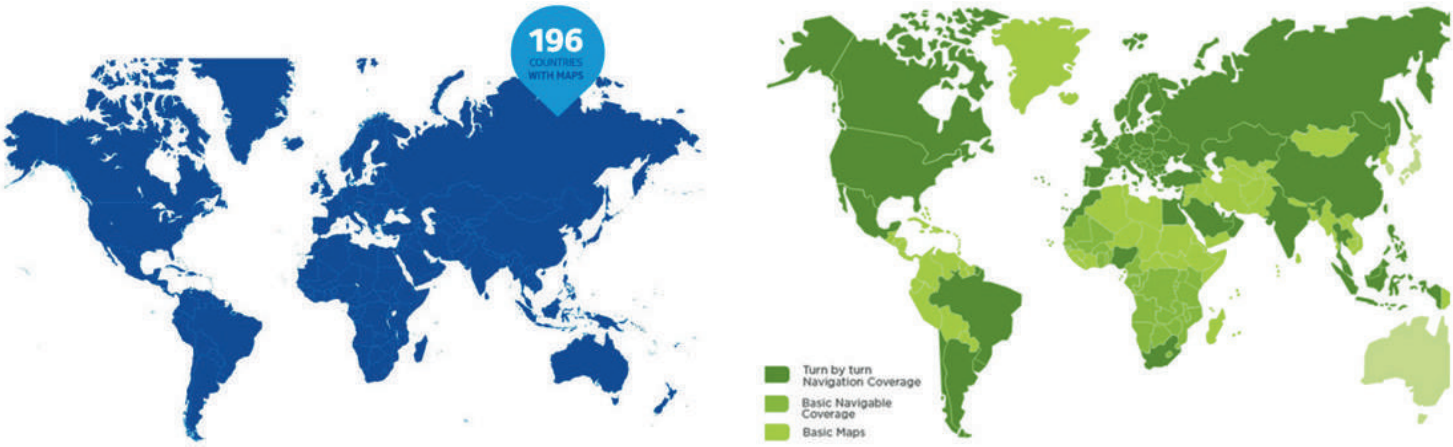


Fig. 44: HERE (formerly Navteq, left) and TomTom (right) Global Coverage

5.5 TomTom

TomTom has a road navigation coverage for 118 countries extending over North America, Brazil, Argentina, Europe, the Russian Federation, India, Indonesia, Thailand, Australia, New Zealand, West and South Africa (see Fig. 44).

6 Mapping by Military Organizations

Like it happened during the cold war period, when the US and the USSR military organizations considered it their goal to conduct mapping operations in what they considered to be crisis areas, this practice was recently revived by about 30 nations from Europe, North America, Australia, New Zealand, Japan, Rep. of Korea and South Africa, when they launched the Multinational Geospatial Co-Production Program MGCP. The goal of this program is to generate up-to-date 1:50 000 digital maps for potential crisis areas of the globe in Asia, Africa, the Middle East, the West Indies and the Pacific Ocean. Benefitting from this activity is the UN cartographic section, which utilizes these maps to create information for crisis mitigation.

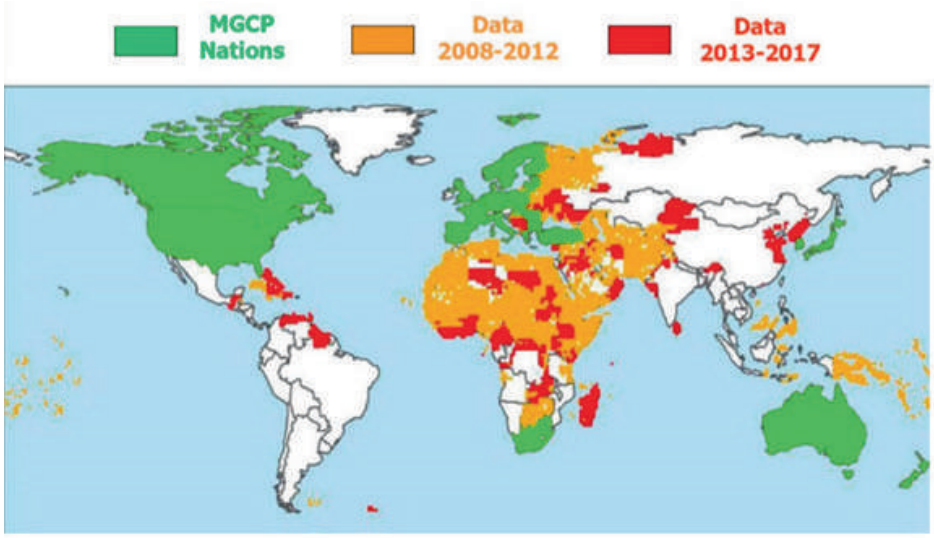


Fig. 45: MGCP Mapping Coverage

7 Other Mapping Efforts

- Open Street Map is the voluntary Crowd sourcing attempt to update map content by the public. It has been enthusiastically promoted in most parts of the globe but it must be integrated into authoritative mapping to guarantee quality control.
- Scan Map by Eastview is a new commercial venture to integrative authoritative mapping with population statistics.

8 Summary of Results

- 115 UN Member countries have responded to the 2012-2015 UNGGIM-ISPRS Survey. It has been shown, that nearly all reporting countries have modernized their facilities to adopt modern GNSS, digital imaging and GIS technology in their operations, which are still handicapped by lack of funding and staff shortages.
- While in 1986 the world was basically covered by 1:250 000 maps, progress in technology has now made it possible to state that topographic mapping of the globe at 1:50 000 scale, relevant to sustainable development, has been reached.
- There are still gaps in providing updated information in developing countries. These need to be closed with a goal of no data to be older than 5 years.
- New technologies, such as those used by Google and by Yandex could help to reach this goal in priority areas.

9 Future Activities

- ISPRS has created working group IV-2 to accompany the UNGGIM-ISPRS project.
- This working group has successfully provided the needed discussion forum for the task.
- It will be the future goal of this group to assure that the data collection and analysis will be sustainable by cooperating with UNGGIM and UN-GEO
- A near goal will be the expansion of the work to include global land cover mapping as a task.

10 References

1. UN Secretariat document E/CONF78/BP7 1986, prepared by A. J. Brandenberger & S.K. Ghosh, published in World Cartography XiX, 1990
2. UN Secretariat document E/CONF78/BP8 1986, prepared by G. Konecny, published in World Cartography XIX, 1990
3. Global Geospatial Information and High Resolution Global Land Cover/Land Use Mapping. Proceedings of ISPRS WG IV/2 Workshop, April 2015, Novosibirsk
    - The Global Status of Topographic Mapping, Gottfried Konecny, pp. 4 - 20
    - The Global Status of Topographic Mapping: Technical Background, Uwe Breitkopf, p. 21
    - The Current Status of Mapping in the World - Spotlight on Pacific Islands, John Trinder, pp. 22 - 32
    - High Resolution Global Land Cover/Land Use Mapping. Current Status, Klaus U. Komp, pp. 33 - 47

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Appendix I Original Questionnaire

QUESTIONNAIRE
ON
THE CURRENT STATUS OF MAPPING IN THE WORLD

The questionnaire is intended to take stock of the current status of mapping in the world. The information collected will eventually be used to develop country profiles, good practices and lessons learned in the dissemination and use of geospatial data. The results of this questionnaire will be collated and disseminated to countries.

Please submit the completed questionnaire and any attachments in electronic format to Mr. Amor Laaribi (E-mail: Laaribi@un.org) or to Ms Vilma Frani (Frani@un.org) by **1 June 2012** at the latest. You may also submit additional material by fax at +1-212-963-9851.

Thank you in advance for your input.

Steps to follow in checking a box:

1. Left double-click on the box
2. Select "Checked" for default value
3. Click "OK".

PART A: BACKGROUND INFORMATION

Please provide the following information on the person filling the questionnaire:

Name of person filling the questionnaire:
Functional title:
Institution, department or unit:
Country:
E-mail:
Persons/Institutions consulted:

PART B: National Topographic Mapping Coverage

1. At what scales are topographic digital data and/or map products (or series) produced and maintained? Choose the categories closest to your scales if they are different to those suggested below.

Category: I	1: 1000 or greater	☐
II	1: 5000	☐
III	1: 25 000	☐
IV	1: 50 000	☐
V	1:100 000	☐
VI	1:250 000	☐
VII	1:500 000	☐
VIII	1:1 million or smaller	☐

In each case indicate the reference datum used.

2. If possible, provide indexes that show the coverage of these data and/or maps by category in graphic form.

   If possible, distinguish between the age of available maps and/or data (e.g. 1yr, 2yrs, 3yrs, 4 to 7yrs, 8 to 15yrs, over 15yrs), state the year of publication[1]

3. Do the maps and/or data have restricted access or limited circulation?

   Yes ☐ No ☐

   If so, can you indicate why and to whom?

   _____

   _____

4. Are the maps and/or digital data sold to the public?

   Yes ☐ No ☐

   Or are the maps and/or digital data free of charge?

   Yes ☐ No ☐

   Are they free of charge to governmental institutions or certain stakeholders?

   Yes ☐ No ☐

   What maps or data are available on the web, and are they free?

   _____

   _____

[1] Even if we know that this may be difficult to do so for the digital data.

If applicable, could you indicate what pricing model is being applied to the map products and the digital data?

5. Is there a cycle of map and data revision by:
   - ☐ Complete mapping ie. revision of a national series
   - ☐ Mapping of changed features or themes across the national series
   - ☐ Mapping of changed features as they are detected on an ad-hoc basis

Is the data revision reflected across all map/data scales indicated in Question 1?

Yes ☐ No ☐

If not, state the revision cycle for each map and/or data scale

6. By what methods is national data revision and map updating undertaken (if multiple methods, please indicate):
   - ☐ Field surveys
   - ☐ Aerial photography
   - ☐ Photogrammetric
   - ☐ Satellite imagery
   - ☐ Third party data and/or sources
   - ☐ Crowd sourcing by volunteers and/or other means

If there is a prevalent method of mapping by category I to VIII for each map scale, please indicate for each.

7. Is mapping and map updating done in-house or by outsourcing?

In-house ☐ Outsourcing ☐

Where applicable, can you describe the activities, processes and mechanisms by which the outsourcing is conducted?

PART C: National Imagery Acquisition

8. Does a national aerial photography acquisition program exist? Yes ☐ No ☐
   - Do you have a domestic aerial imagery capability? Yes ☐ No ☐
   - Or is it obtained internationally? Yes ☐ No ☐
   - Is imagery flown at regular time intervals? Yes ☐ No ☐
   - Is analogue or digital photography used? Analog ☐ Digital ☐

9. Does a national satellite imagery acquisition program exist? Yes ☐ No ☐
   - Do you have a domestic satellite imagery capability? Yes ☐ No ☐
   - Or is it obtained internationally? Yes ☐ No ☐
   - Is satellite imagery acquired systematically at regular time intervals? Yes ☐ No ☐
   - Or is satellite imagery acquired on an 'as needs' basis? Yes ☐ No ☐

10. Do you acquire and/or use other imagery types (such as LiDAR, Radar, IFSAR, etc.)?

Yes ☐ No ☐

If so, can you please indicate coverage and resolution? (For example: LiDAR along the coastal strip at 15cm pixel resolution).

11. Are any of these new imagery acquisition types (such as LiDAR) being used for the generation of digital elevation models (DEMs), digital terrain models (DTMs), and/or digital surface models (DSMs)? State pts/m^2 and the coverage in km^2 if possible.

12. Are orthophotos and orthophotomaps produced?

Yes ☐ No ☐

At what scale?

If possible, show coverage and age at different scales in graphical form.

13. Is there a national digital elevation model (DEM) available?

Yes ☐ No ☐

If applicable, show the resolution and coverage of any sub-national DEM, DTM and DSM data and/or products.

14. Do you produce, or is there the intention to produce, 3D urban and rural landscape models and/or product visualization?

Yes ☐ No ☐

PART D: National Surveying and Cadastral Coverage

15. Are there licensed surveyors operating in the country?

Yes ☐ No ☐

16. Is there national coverage of cadastral maps and/or data available?

Yes ☐ No ☐

Is the National Mapping Agency (NMA) responsible for surveying and/or land titles and cadastre?

Yes ☐ No ☐

If the NMA is not responsible for these, please indicate the relevant agency/s that are responsible.

_____

_____

17. What are the cadastral maps and data used for:

☐ Land registration
☐ Titles
☐ Conveyancing
☐ Taxation
☐ Other

18. Are the cadastral maps based on geodetic control?

Yes ☐ No ☐

If so which reference system is being used?

_____

_____

19. Are the property boundaries monumented in the field?

Yes ☐ No ☐

20. How are the property maps and/or data updated?

_____

_____

_____

21. Could you list the number of government officials and private surveyors active in cadastral surveys?

_____

_____

_____

PART E: Organization

22. Are the national topographic mapping, imagery acquisition, surveying and cadastral programs funded by your national Government?

Yes ☐ No ☐

23. Are you able to provide the annual mapping budget of the National Mapping Organization?

Yes ☐ No ☐

_____

_____

24. What is the number of mapping staff in the Organization, and what is the technical/administration mix?

_____

_____

25. Are there any regulatory or institutional arrangements in place that mandates your organization to fulfil the role as the lead mapping agency in your country?

Yes ☐ No ☐

If so, could you briefly describe them?

_____

_____

_____

_____

26. In terms of approximate percentages (%) how are all of the different map and data products mentioned above delivered? Consider the following channels:

Percentage (%)

_____ ☐ Hard copy paper maps
_____ ☐ Digital data
_____ ☐ Data and products downloaded online
_____ ☐ Via web services

27. What is the method of archival for the national data sets?

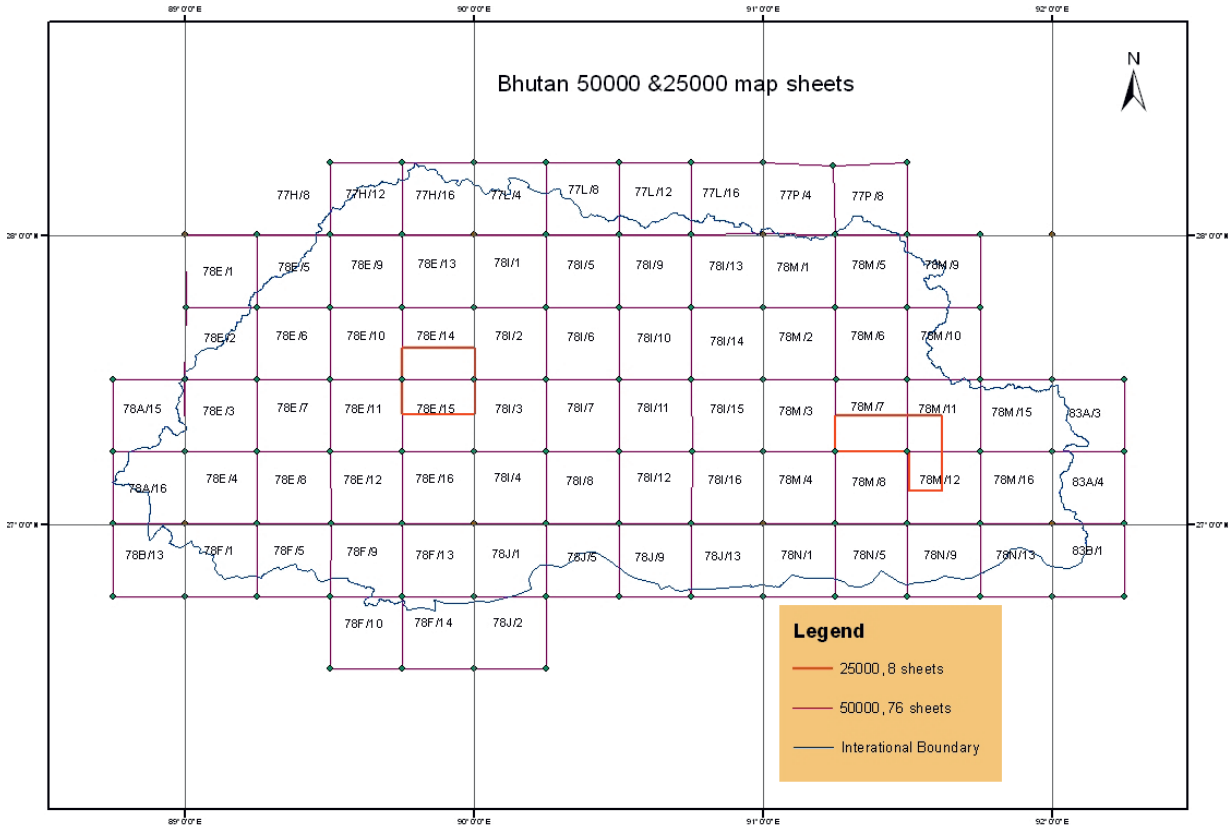
_____

_____

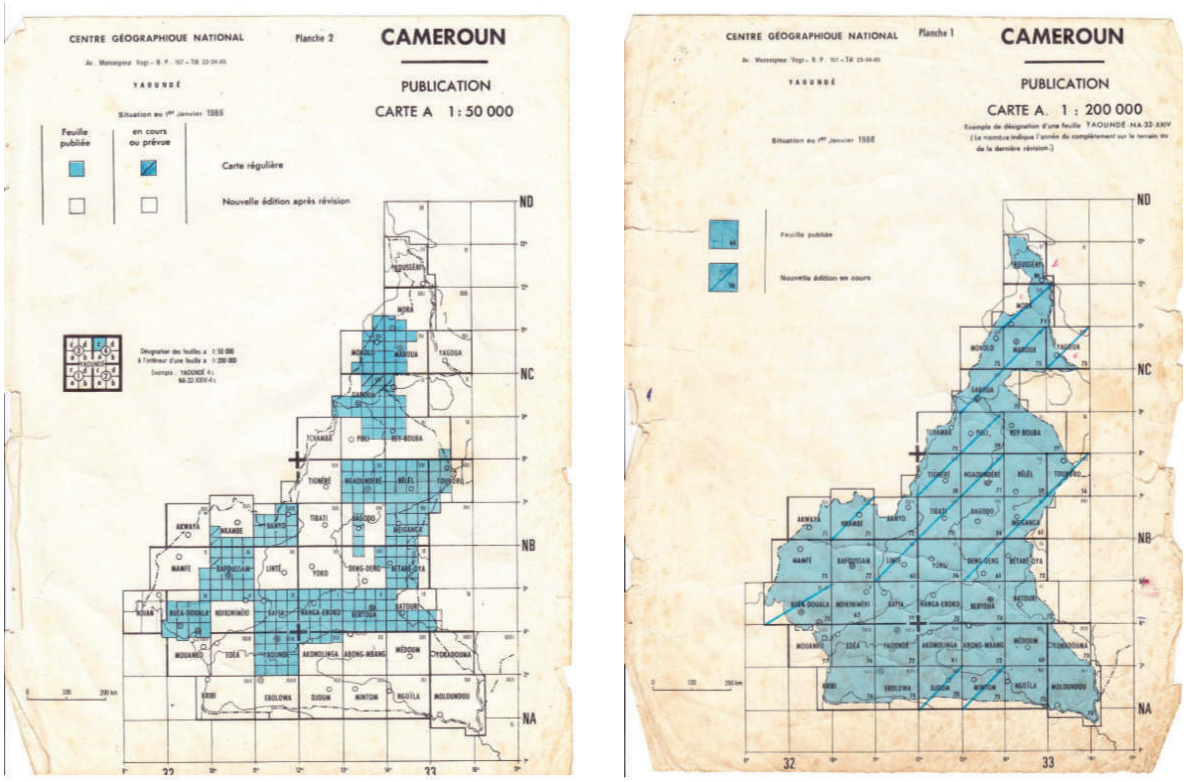
_____

_____

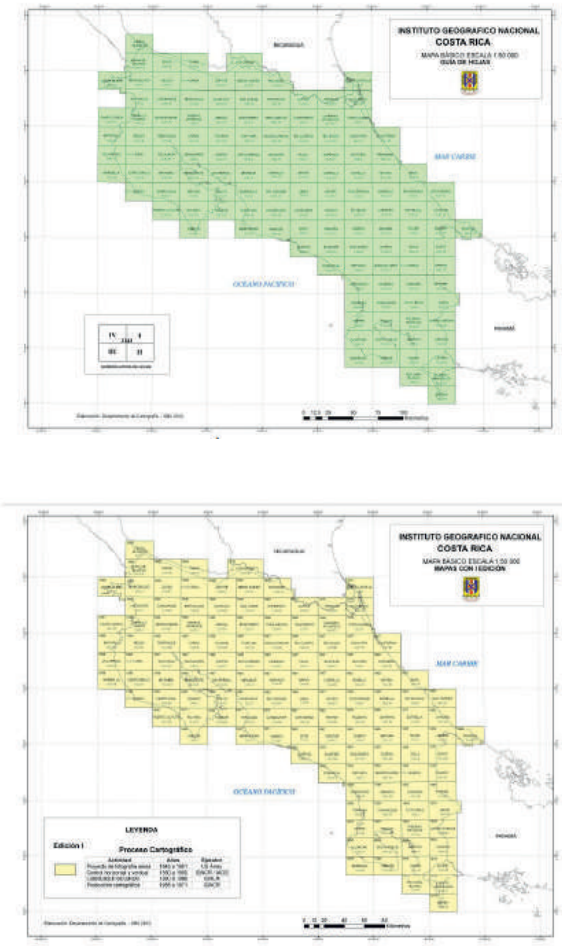
Appendix II Maps from Reports

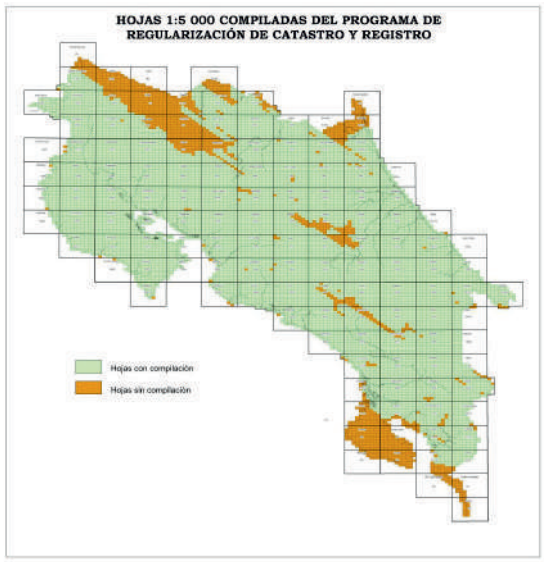


Appendix II-1: Bhutan - 1:50 000 map grid of Bhutan in black, 76 sheets and 1:25 000 map grid of Bhutan in red, 8 sheets

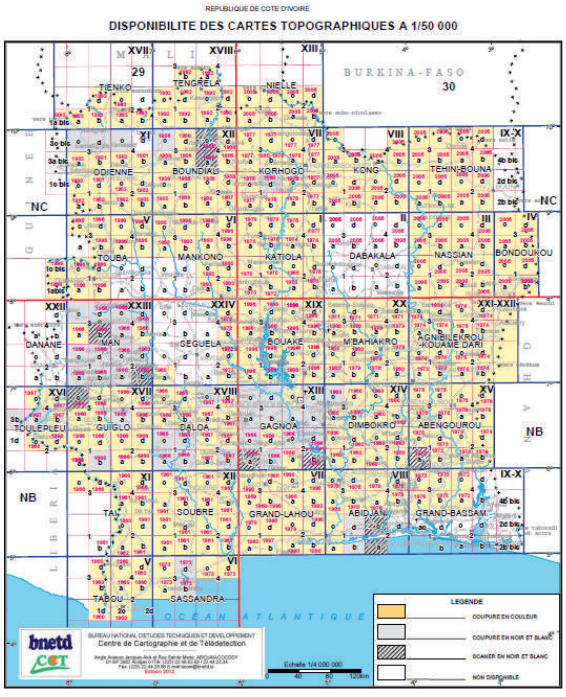


Appendix II-2: Cameroun - 1:50 000 mapping, completed sheets in blue (left) and 1:200 000 mapping, completed sheets in blue (right)

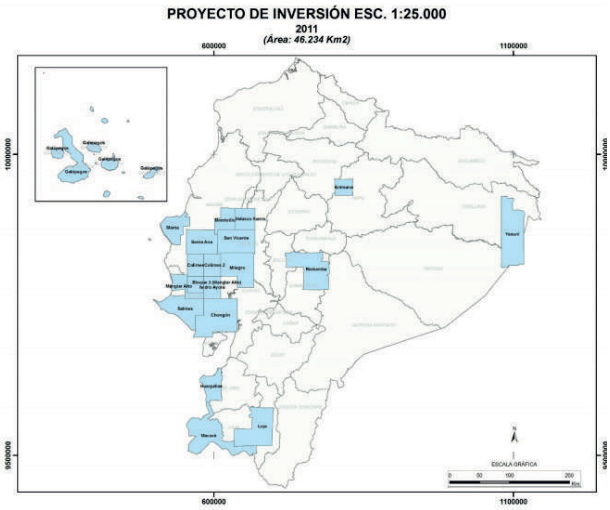




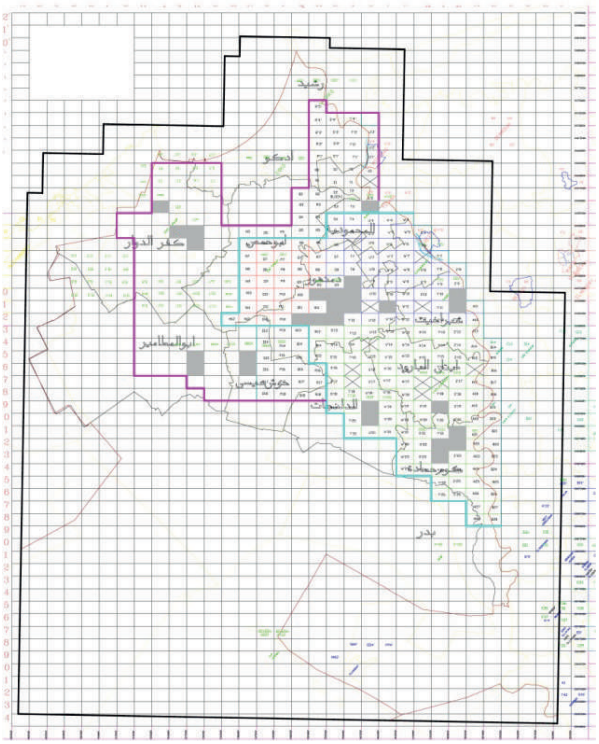
Appendix II-3: Costa Rica - 1:50 000 mapping, completed sheets (left) and 1:5 000 cadastre maps; completed sheets in green, not completed sheets in brown (right)



Appendix II-4: Cote d' Ivoire - 1:50 000 mapping; white: not available, yellow: in colour, grey: in black and white

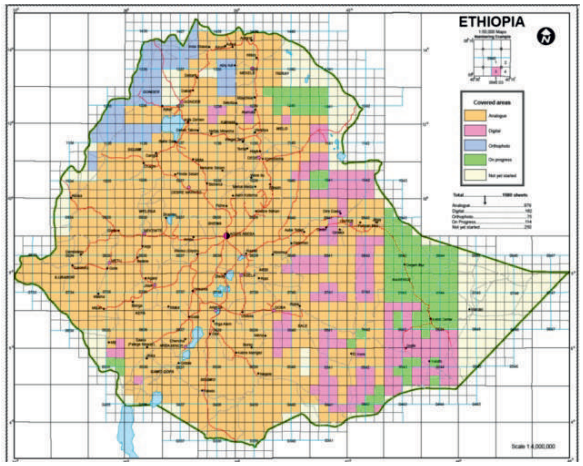


Appendix II-5: Ecuador - 1:25 000

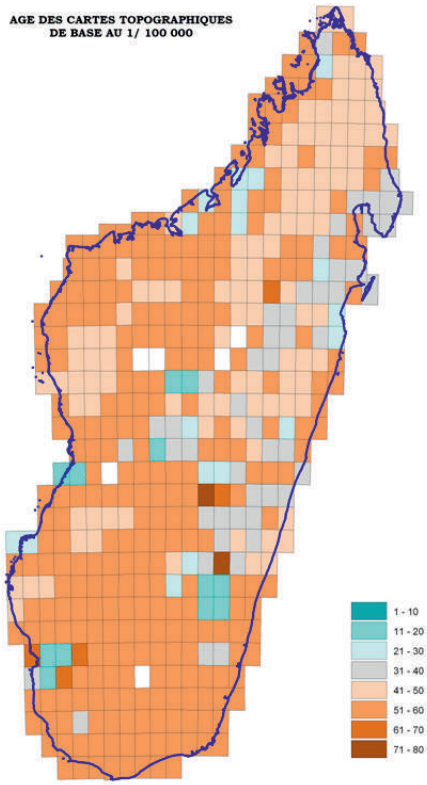


Appendix II-6: Egypt - 1:25 000 mapping of agricultural areas (Nile Delta) as example

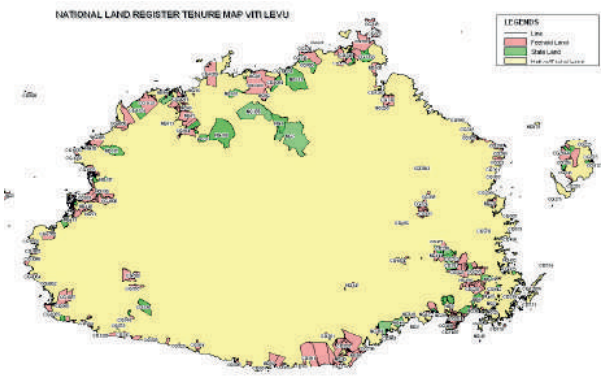
Appendix II-8: El Salvador - 1:25 000 mapping (complete)



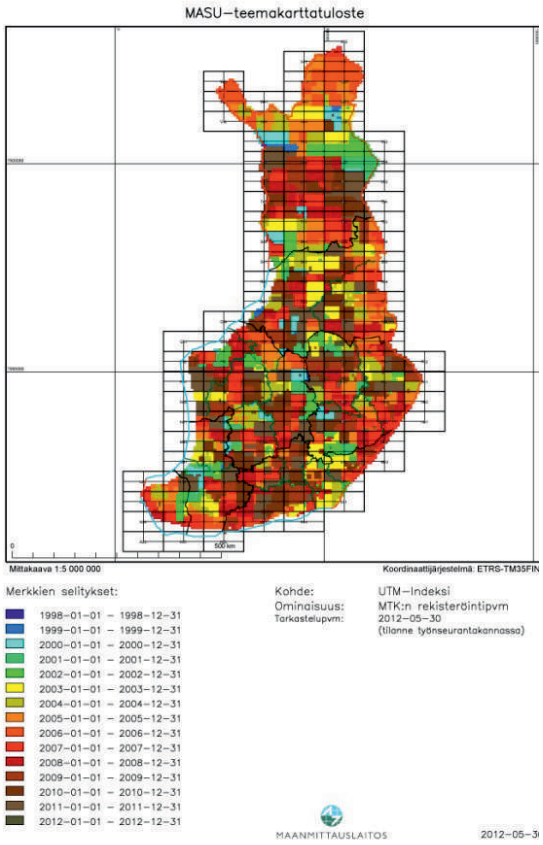
Appendix II-9: Ethiopia 1:50 000



Appendix II-7: Madagascar - 1:100 000 mapping, age of data: blue: 1-10 year old maps, dark brown: 71 to 81 years old

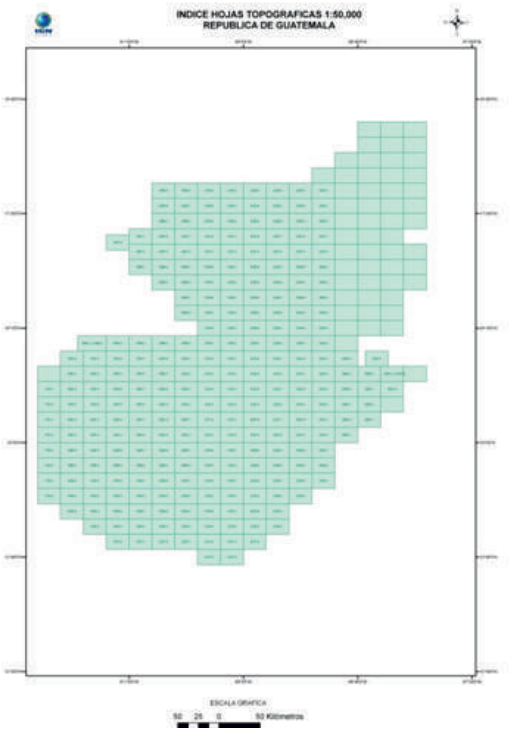


Appendix II-10: Fiji land register

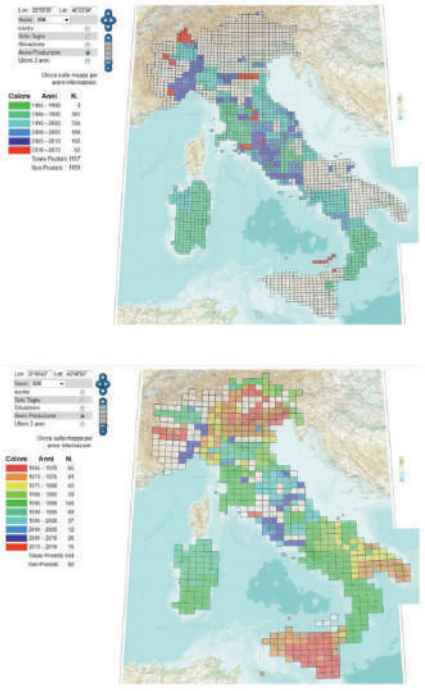


Appendix II-11: Finland - 1:50 000 Thematic Maps of Finland and their age

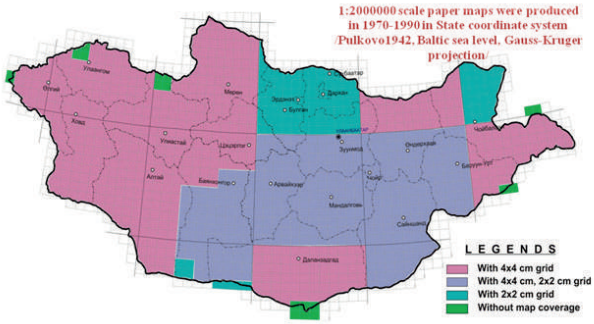
Appendix II-12: Finland - 1:50 000 mapping, age of data between 2005 and 2012



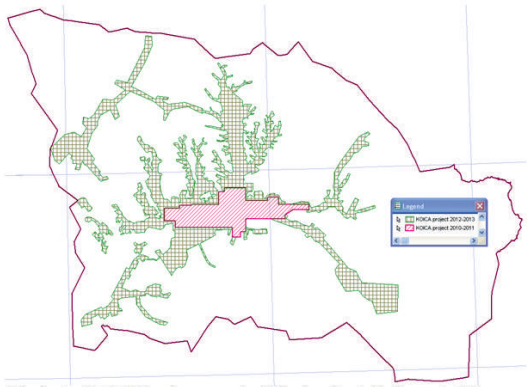
Appendix II-13: Guatemala - 1-50 000

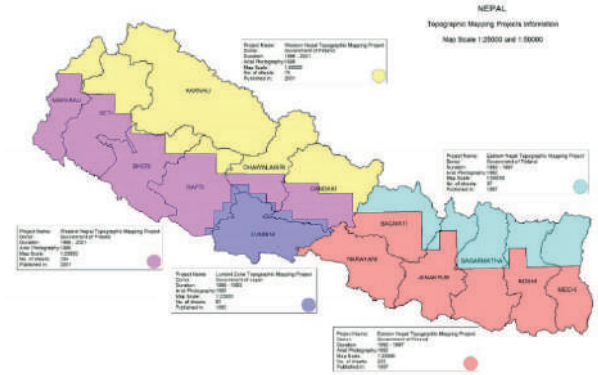


Appendix II-14: Italy - 1:25 000 and 1:50 000 mapping; age of data between 1965 and 2015

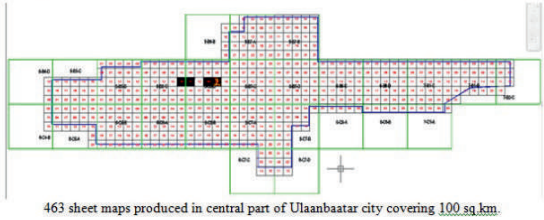


Appendix II-15: Mongolia - 1:200 000, paper map production, 1990

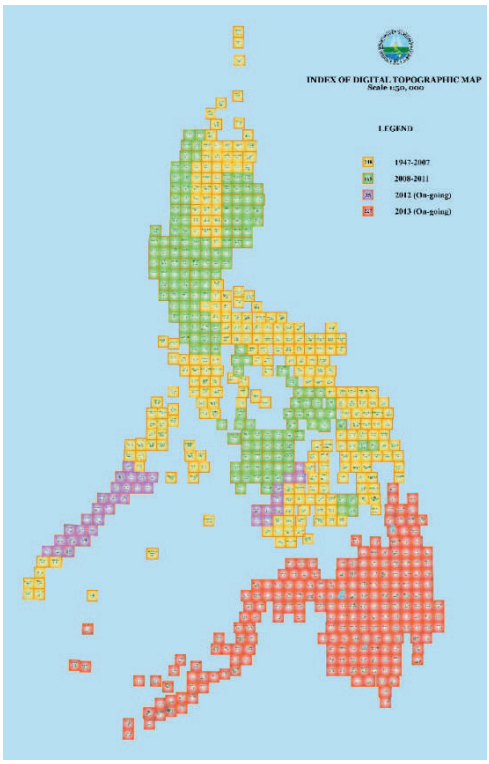




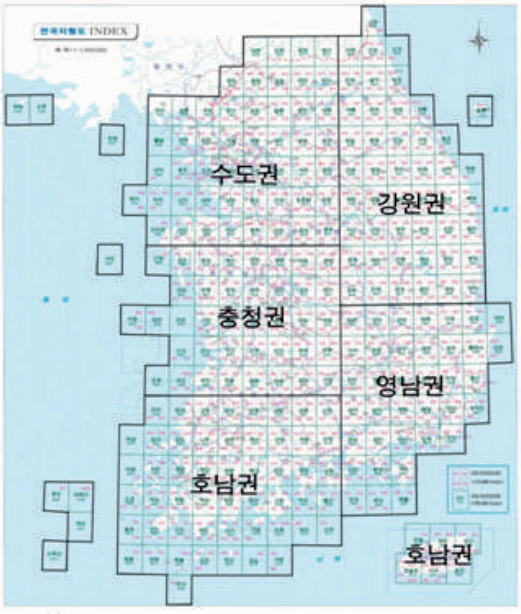
Appendix II-16: Nepal - 1:25 000 and 1:50 000 Mapping of Nepal, 1969 - 2001



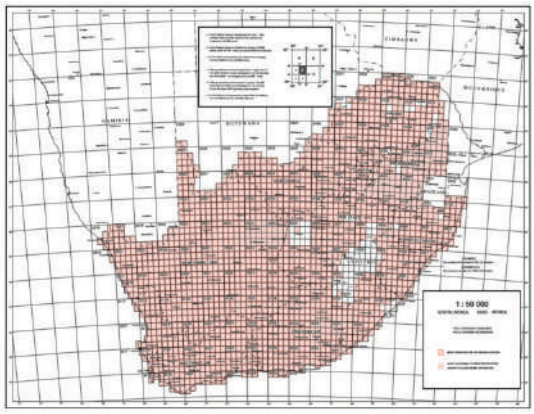
Appendix II-17: Mongolia - 1:1 000 mapping of Ulaanbaatar, 2010 - 2011



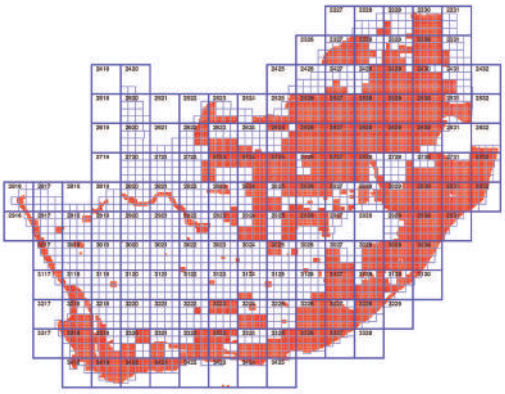
Appendix II-18: Philippines - 1:50 000 Mapping of the Philippines, age of data: yellow: 1947 - 2007, green: 2008 - 2011, violet and red: since 2012



Appendix II-19: Korea (South) - 1: 25 000

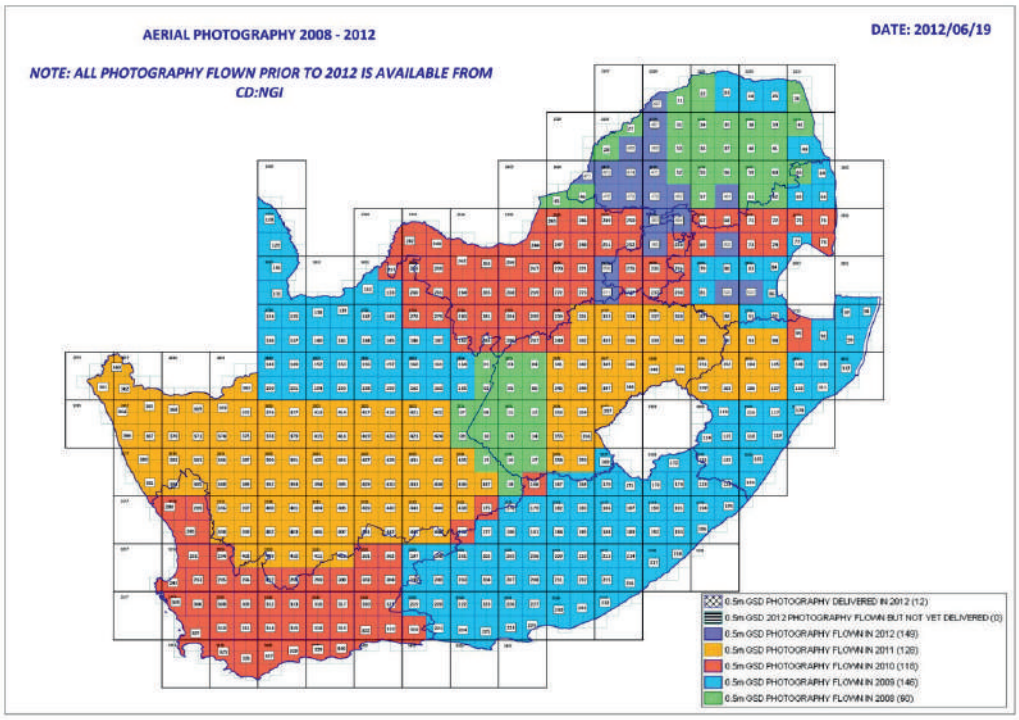


Appendix II-20: South Africa - 1:50 000 mapping



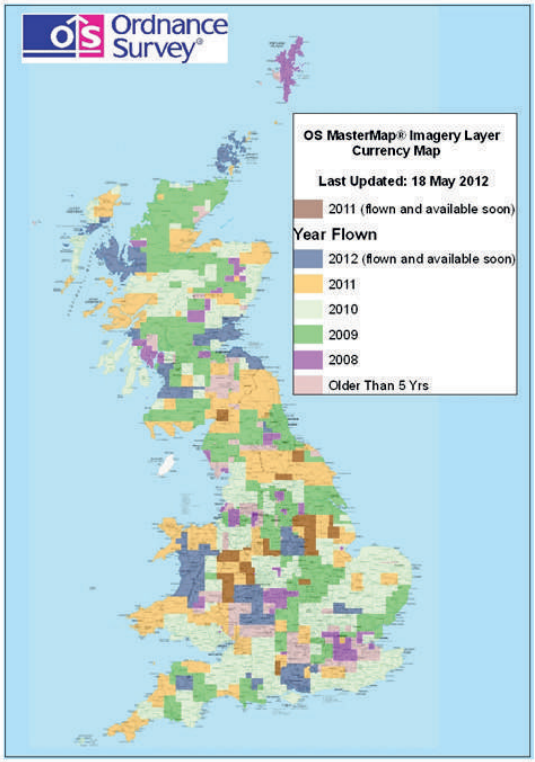
Appendix II-21: South Africa - 1:10 000 Orthophoto Maps completed 2012

Appendix II-22: Uruguay - Map grid for 1:50 000, 1:100 000 and 1:200 000

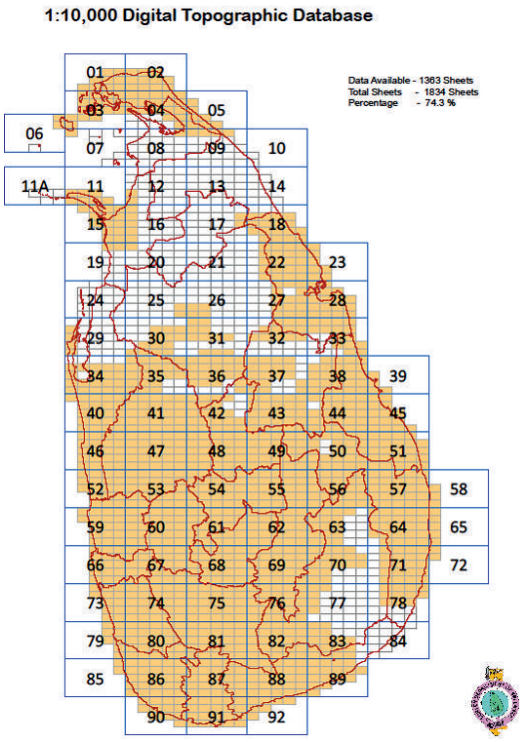


Appendix II-23: South Africa - Aerial photographic coverage, 2008 - 2012

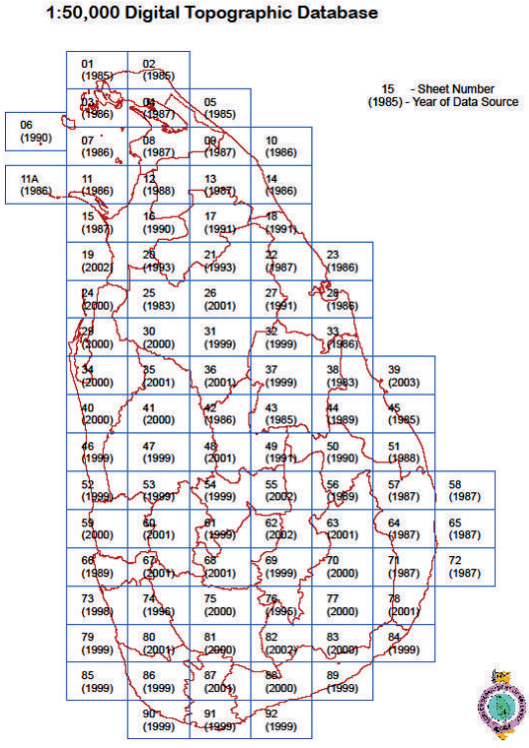
Appendix II-24: United Kingdom - content of master map, all updated within 6 months, dark green: 1:1 250, medium green: 1:2 500, light green 1:10 000



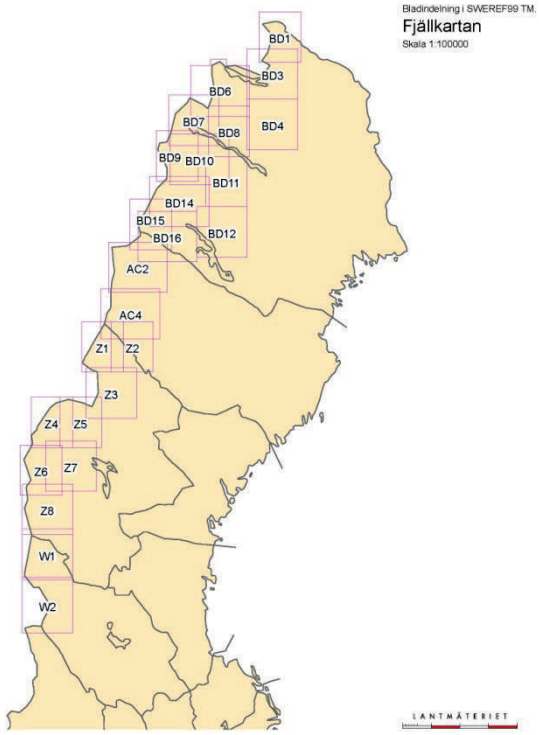
Appendix II-25: United Kingdom - Age of Imagery Layer of Master Map, 2008 - 2012



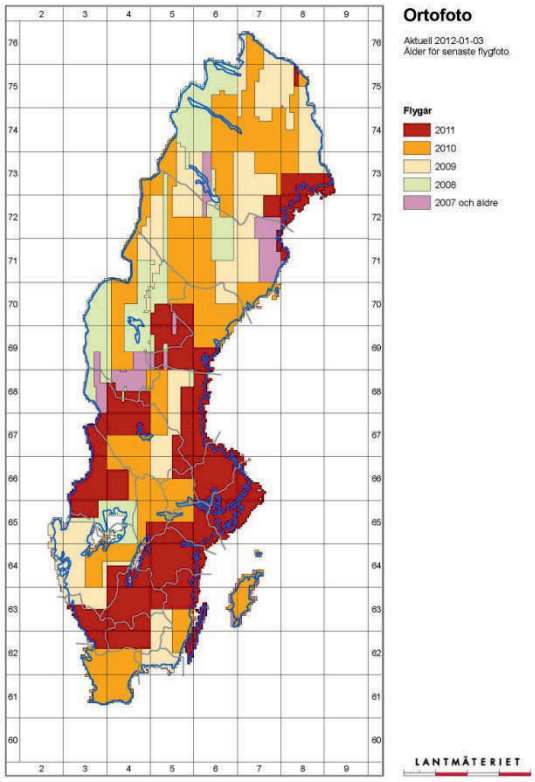
Appendix II-26: Sri Lanka - 1:10 000 mapping, brown: completed



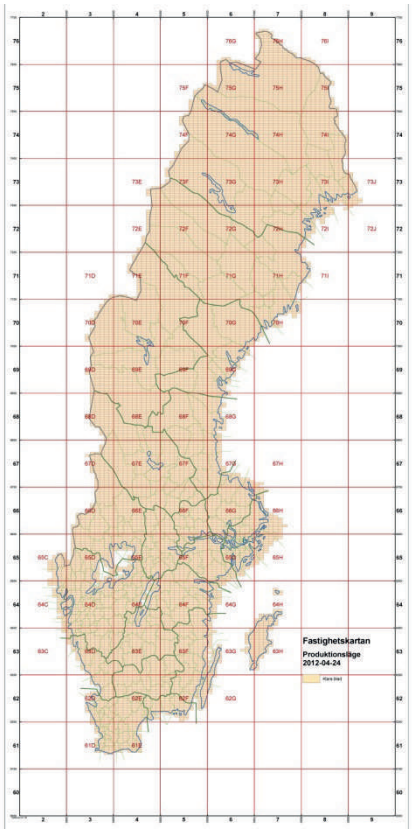
Appendix II-27: Sri Lanka - 1:50 000 mapping completed with year stated



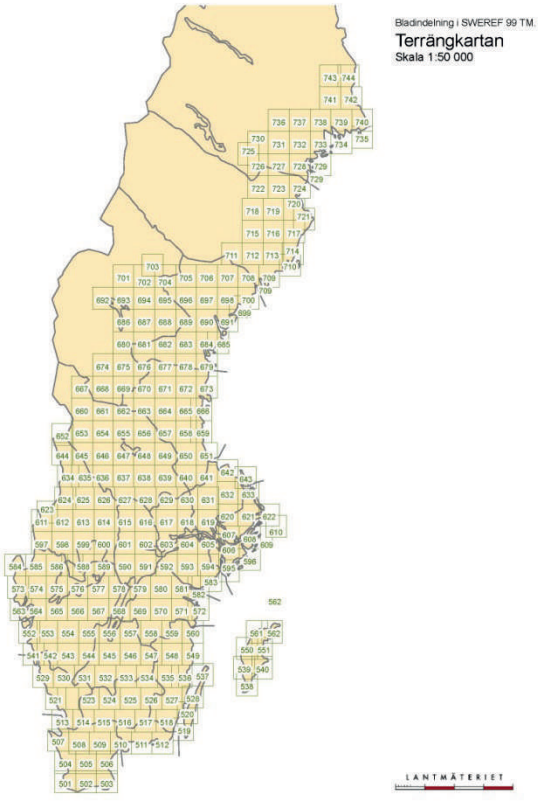
Appendix II-28: Sweden - Mountain area map 1:100 000



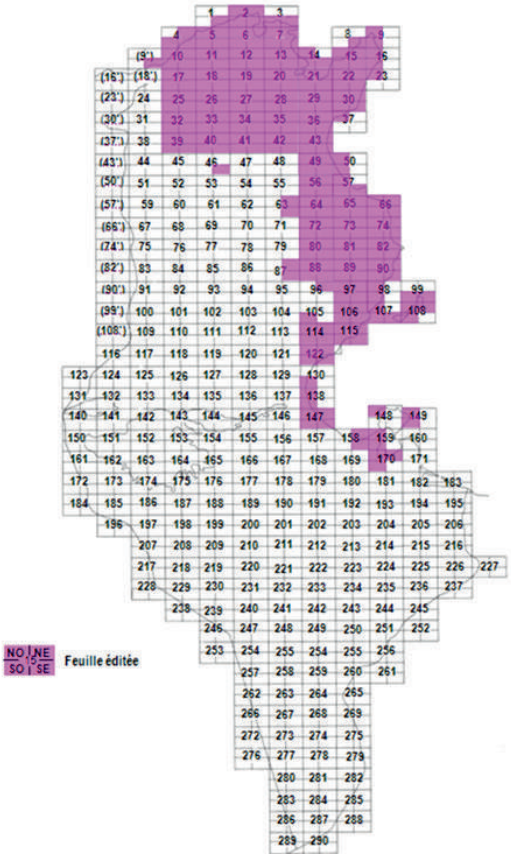
Appendix II-29: Sweden - Age of orthophotos 1:10 000 (2007-2011)



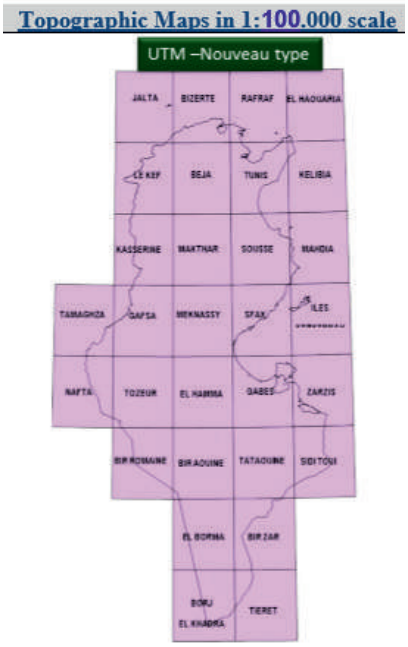
Appendix II-30: Sweden - Property map 1:5 000



Appendix II-31: Sweden - Mapping 1:50 000

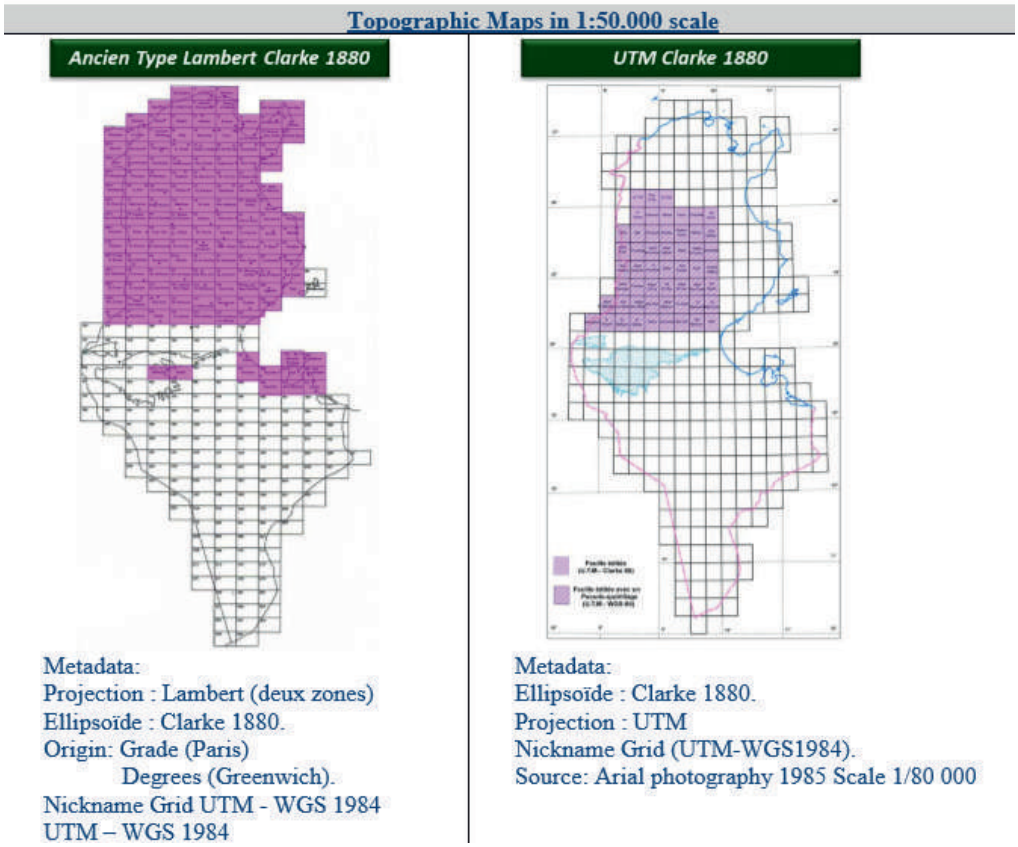


Appendix II-32: Tunisia - 1:25 000 mapping



Metadata:
Ellipsoid: Clarke 1880 / WGS1984
Projection: Universal Transverse Mercator "UTM".
Source: Arial photography 1984 Scal
1/80 000 and completed field 1993.

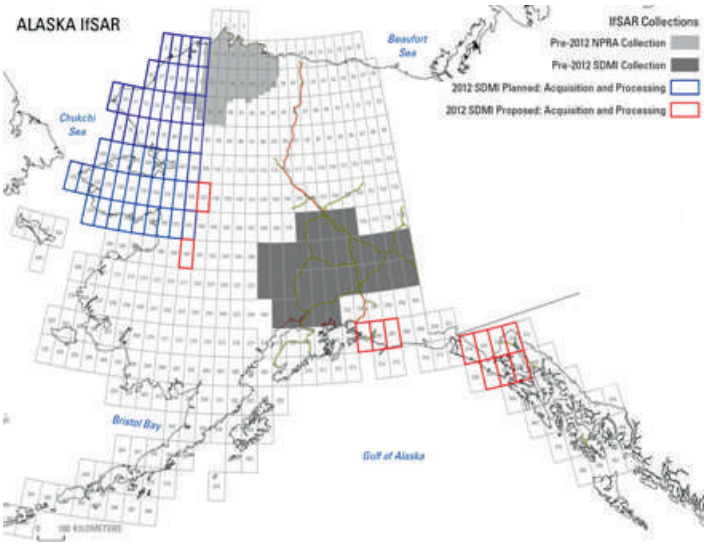
Appendix II-33: Tunisia - 1:100 000



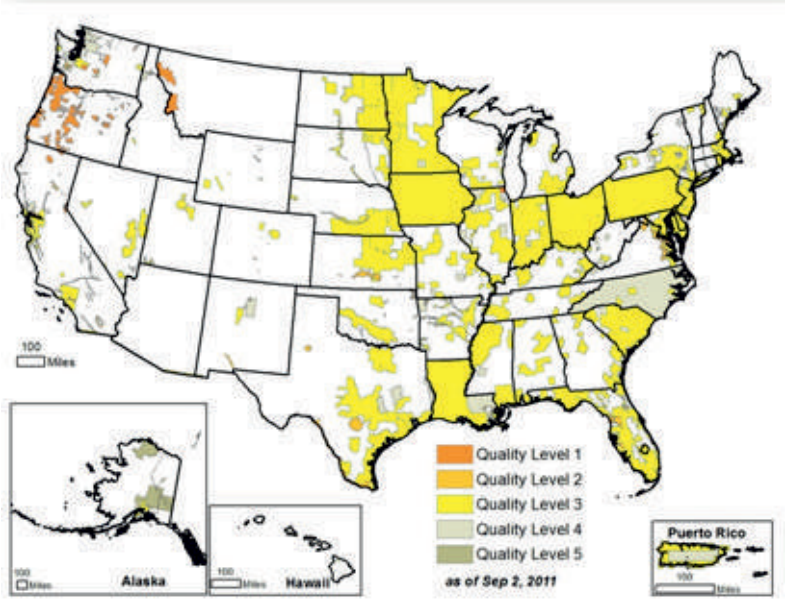
Metadata:
Projection : Lambert (deux zones)
Ellipsoïde : Clarke 1880.
Origin: Grade (Paris)
Degrees (Greenwich).
Nickname Grid UTM - WGS 1984
UTM – WGS 1984

Metadata:
Ellipsoïde : Clarke 1880.
Projection : UTM
Nickname Grid (UTM-WGS1984).
Source: Arial photography 1985 Scale 1/80 000

Appendix II-34: Tunisia - 1:50 000 mapping



Appendix II-35: USA - Alaska INSAR coverage

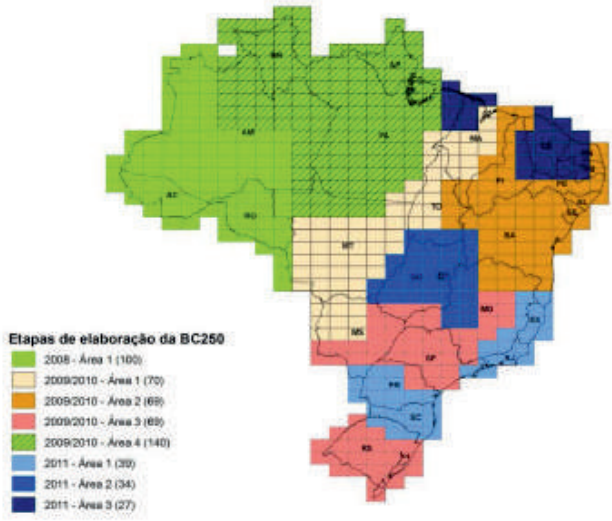


Appendix II-36: USA - Lidar coverage

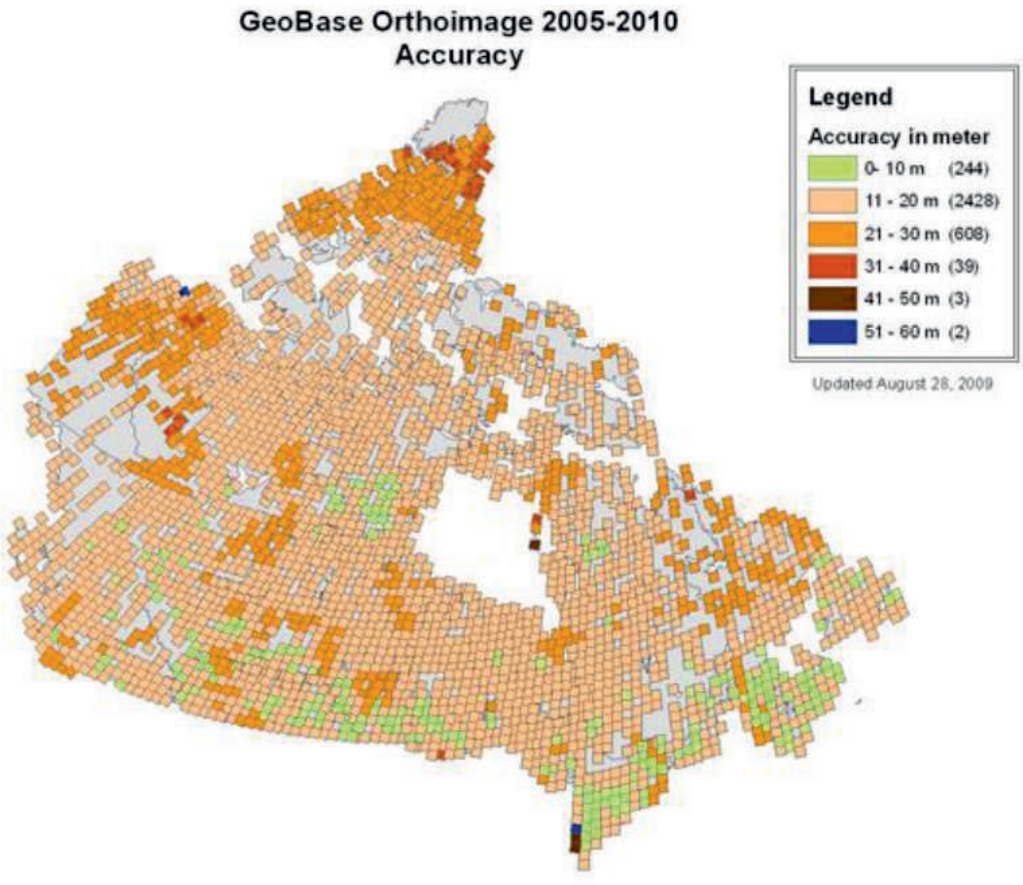
Appendix II-37: USA - Topo updating of 24 000 year cycle

Appendix III Maps from the Internet

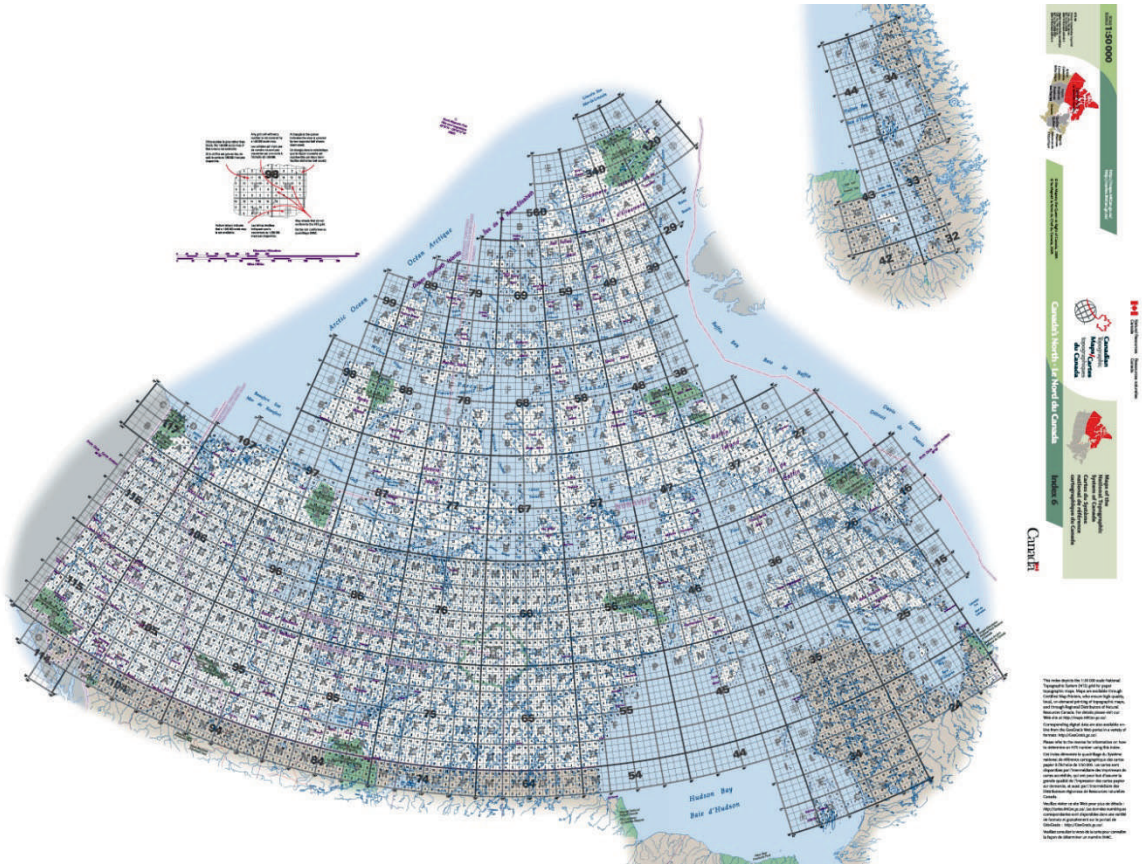
Appendix III-1: Brazil - Continuous coverage of 1:250 000 database



Appendix III-2: Brazil - Updating of 1:250 000 from 2008 to 2011

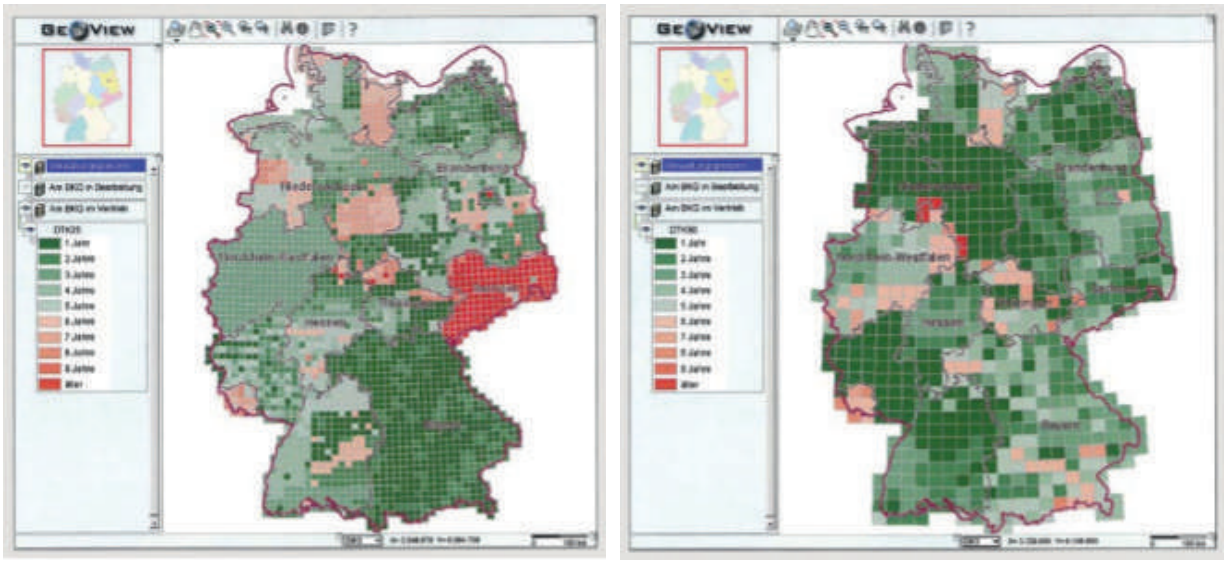


Appendix III-3: Canada - GeoBase orthoimagery (2005-2010), accurancy between 10-60m



Appendix III-4: Canada - Arctic coverage of 1:50 000 maps

Appendix III-5: Czech Republic - Cadastral coverage of the ZABAGED database 1:1 000



Appendix III-6: Germany - Age of topo database 1:10 000 between 1year (dark green) and 9 years (red)

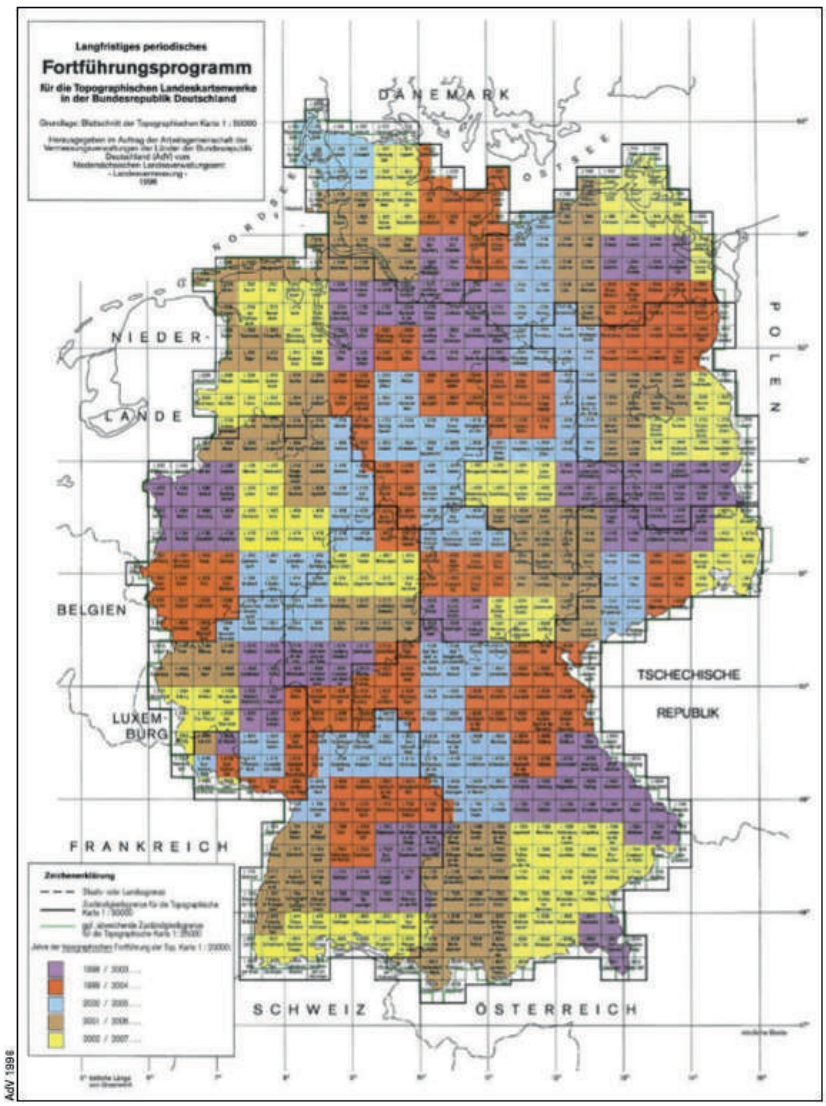
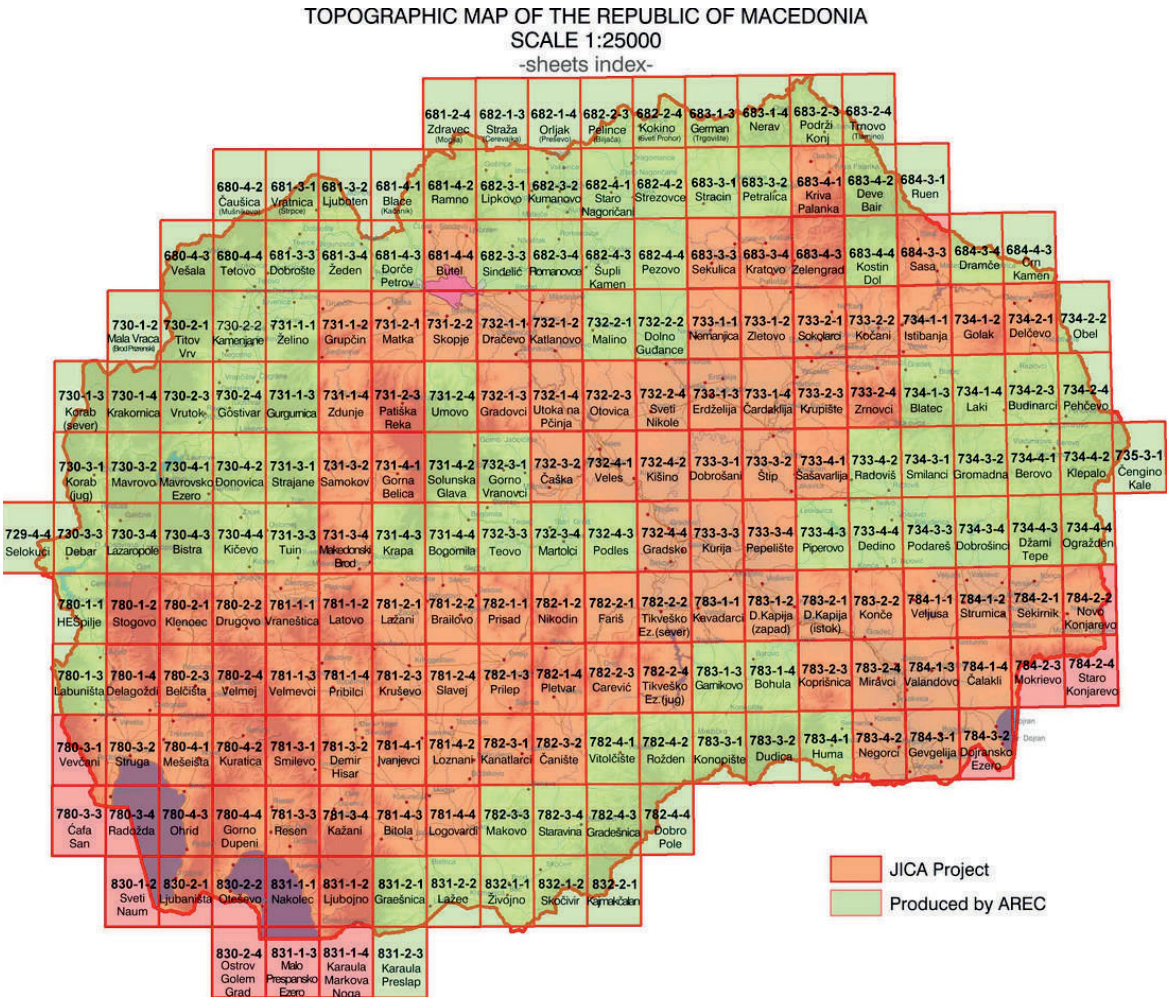
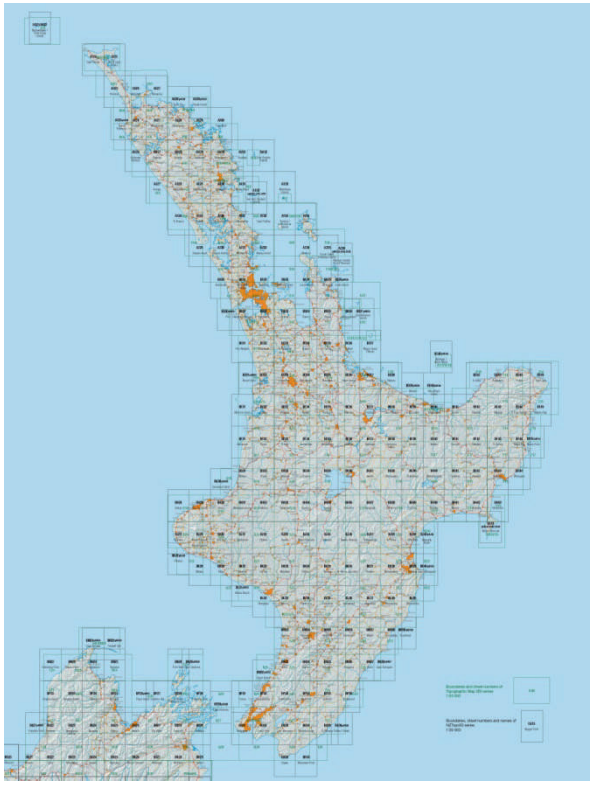


Abb. 1: Historisches »Langfristiges periodisches Fortführungs-programm für die Topo-graphischen Landeskarten-werke«

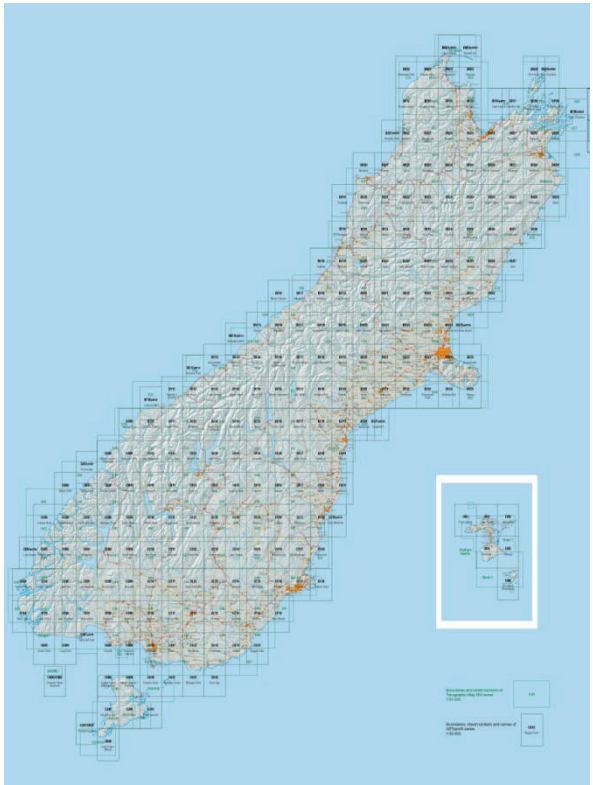
Appendix III-7: Germany - Update cycle of 1:50 000 map sheets, brown: 1996 - 2003 to yellow 2002 - 2007



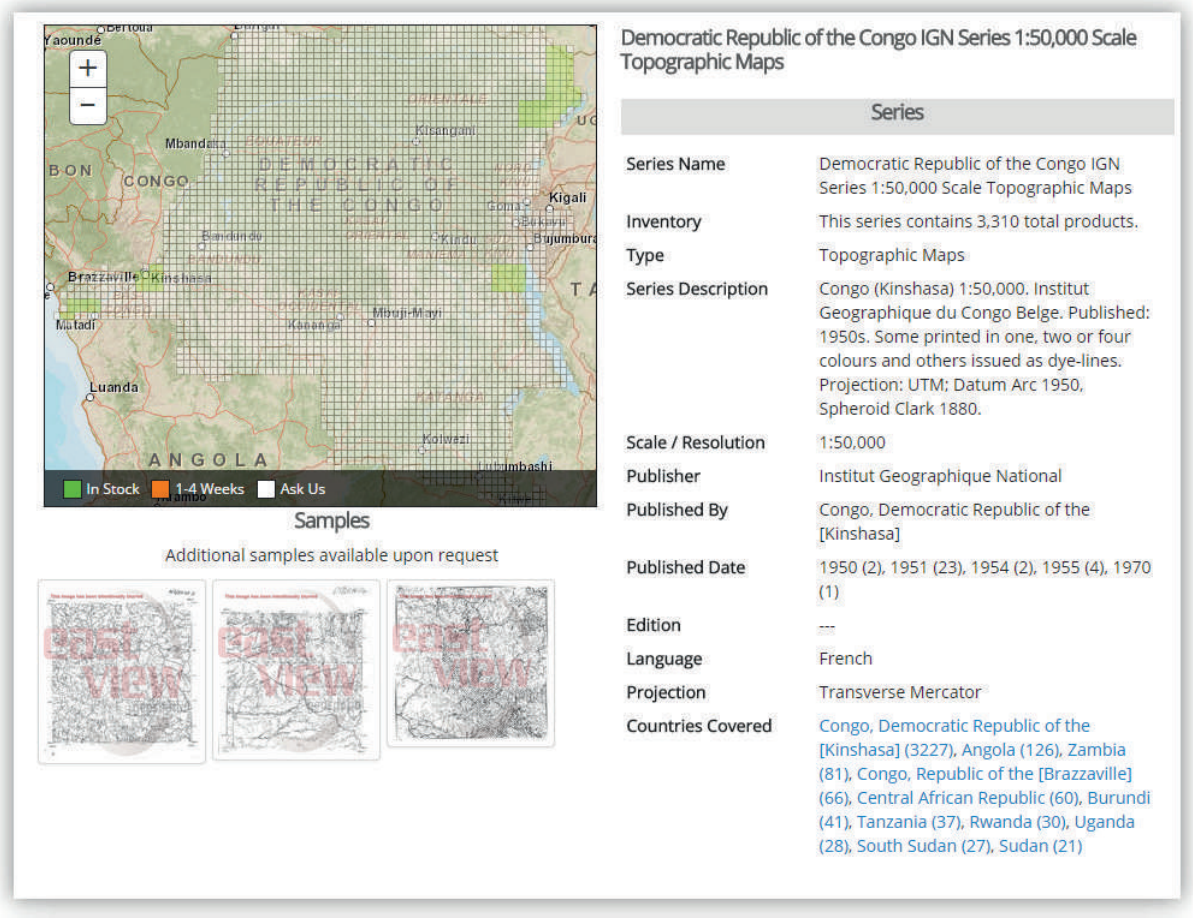
Appendix III-8: FYR Macedonia - 1:25 000 map coverage



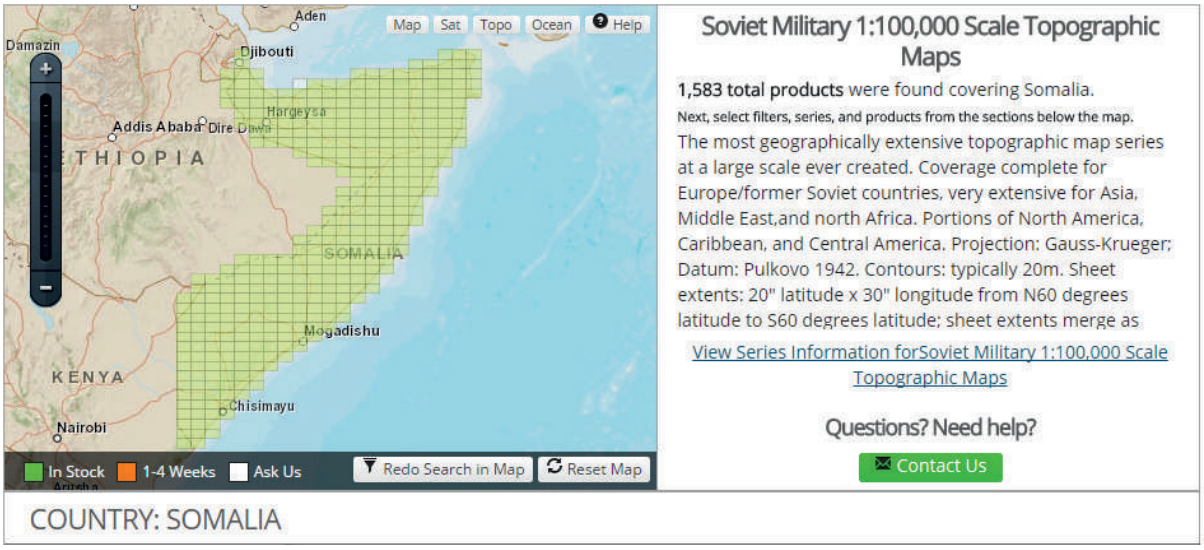
Appendix III-9: New Zealand (North Island) - 1:50 000 mapping



Appendix III-10: New Zealand (South Island) - 1:50 000 mapping

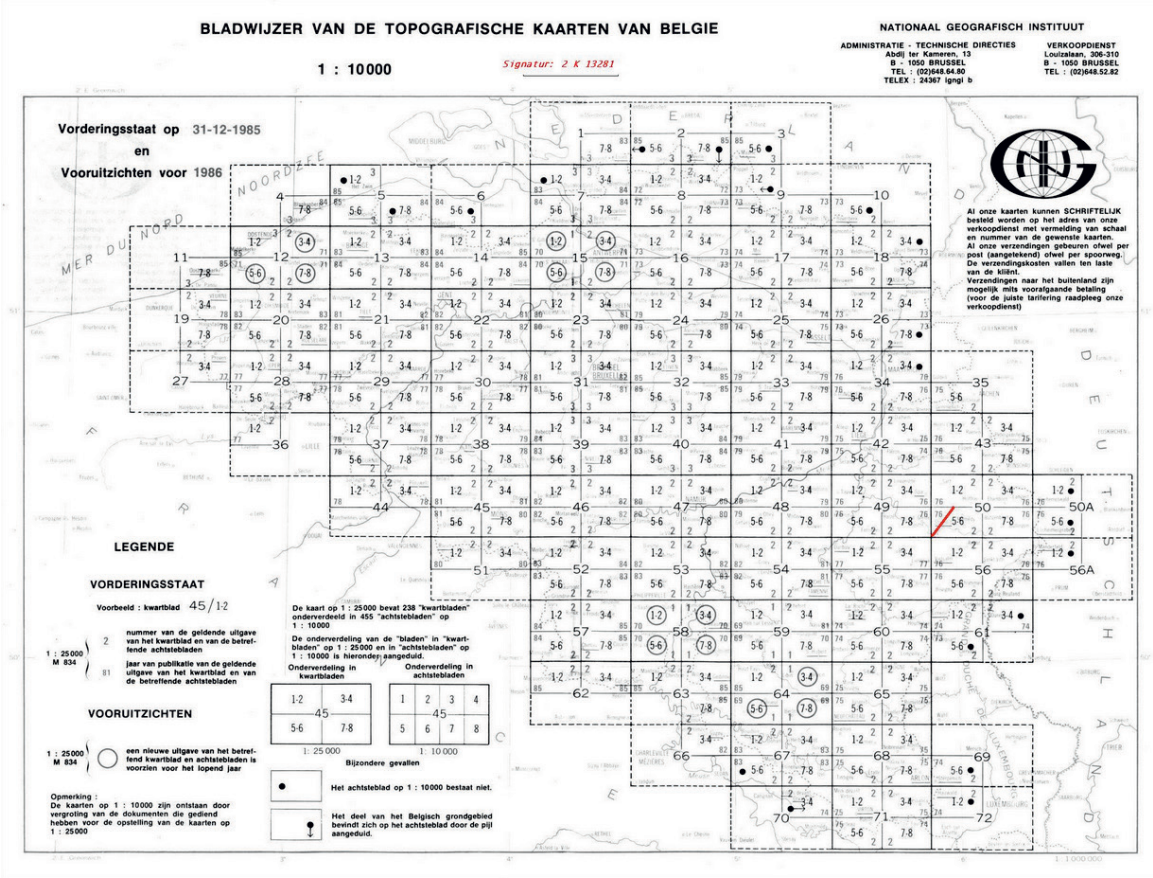


Appendix III-11: Democratic Republic of the Congo 1:50,000 (IGN), example for a locally produced map series available at East View, screenshot geospatial.com



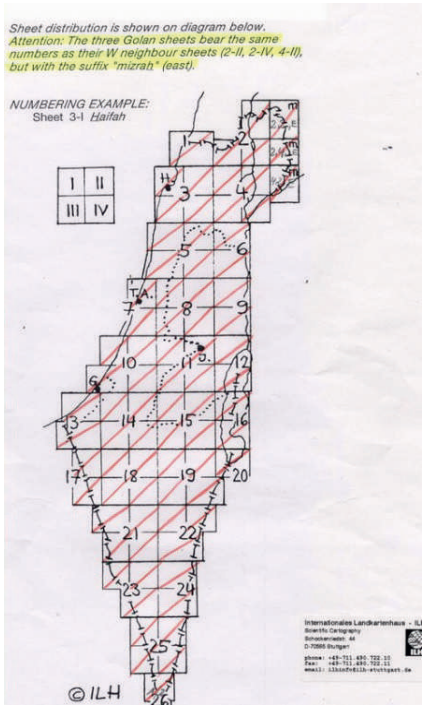
Appendix III-12: Somalia 1:100,000 (Soviet Military), example for a military map series available at East View, screenshot geospatial.com

Appendix IV Maps from Staatsbibliothek Berlin

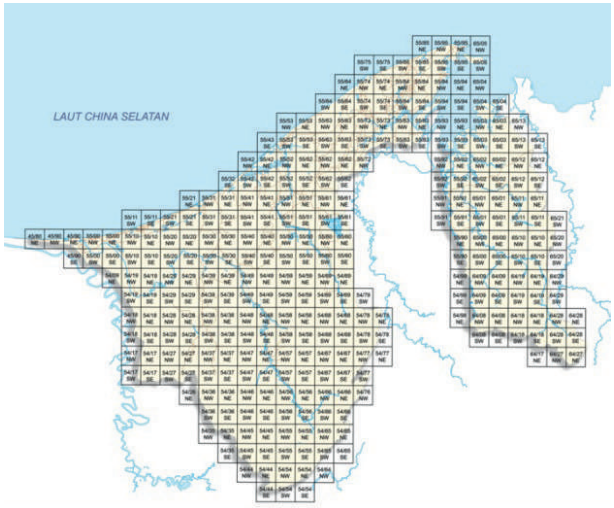


Appendix IV-1: Belgium - 1:10 000 mapping

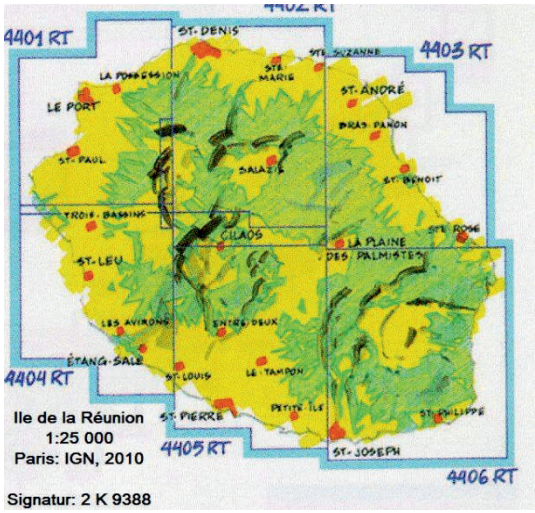
Appendix IV-2: Belize - 1:250 000 mapping



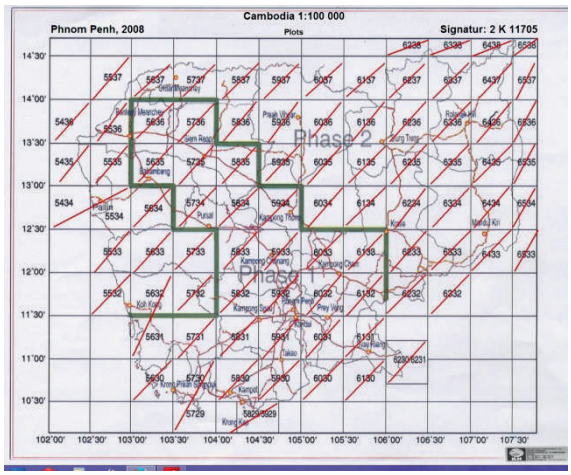
Appendix IV-3: Israel - 1:50 000 mapping



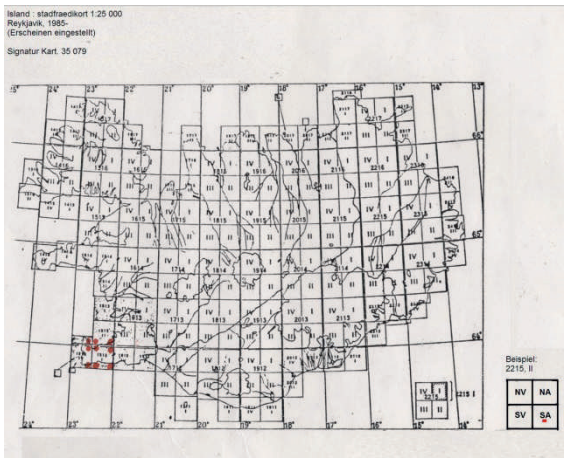
Appendix IV-4: Brunei -
1:10 000 mapping



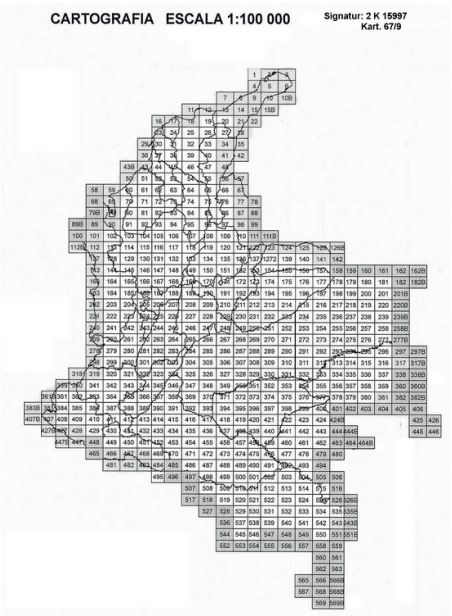
Appendix IV-5: France - Reunion
1:25 000 mapping



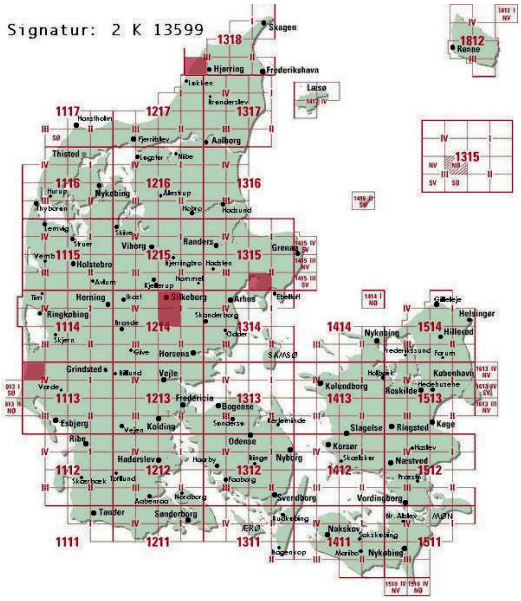
Appendix IV-6: Cambodia -
1:100 000 mapping



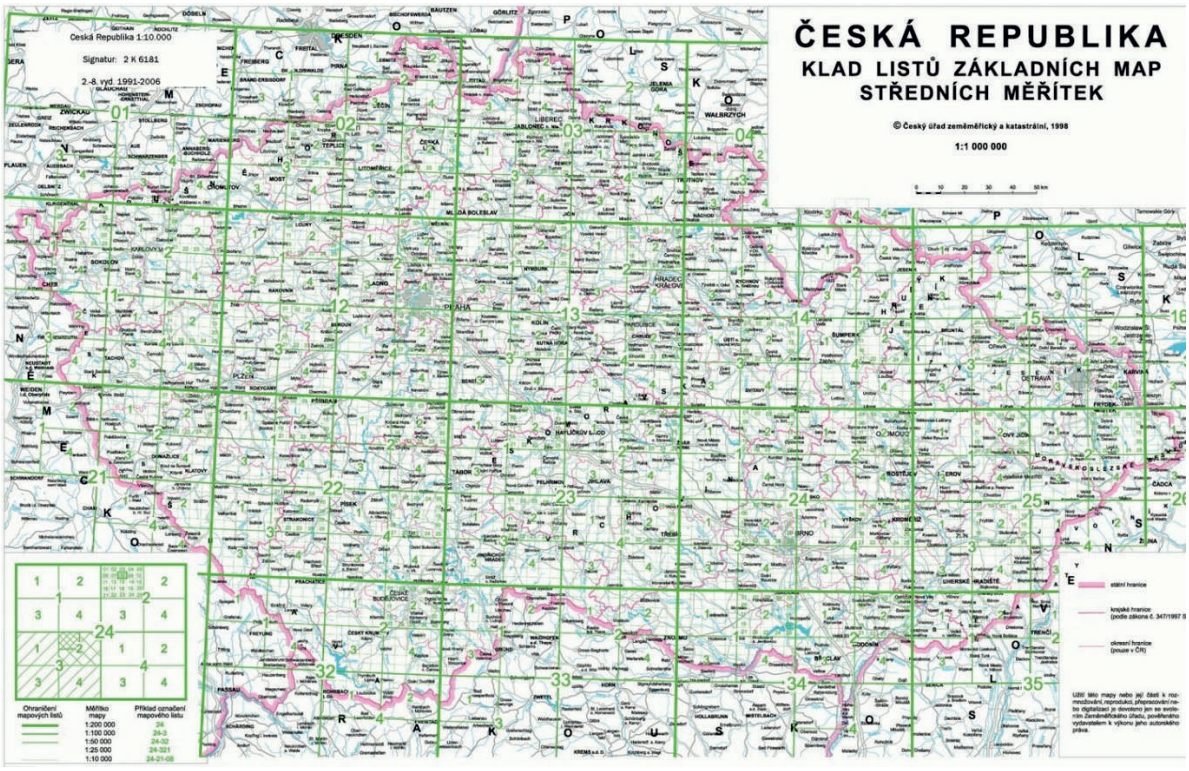
Appendix IV-7: Iceland 1985 -
1-25 000 mapping



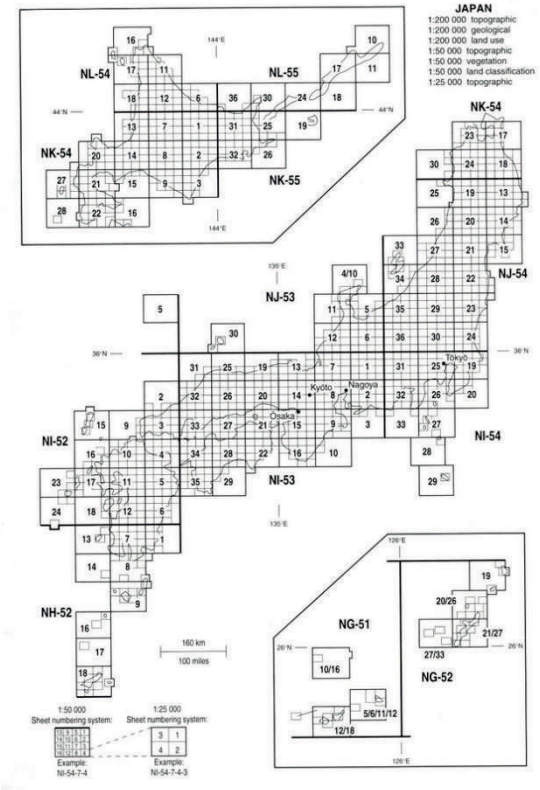
Appendix IV-8: Colombia -
1:100 000 mapping



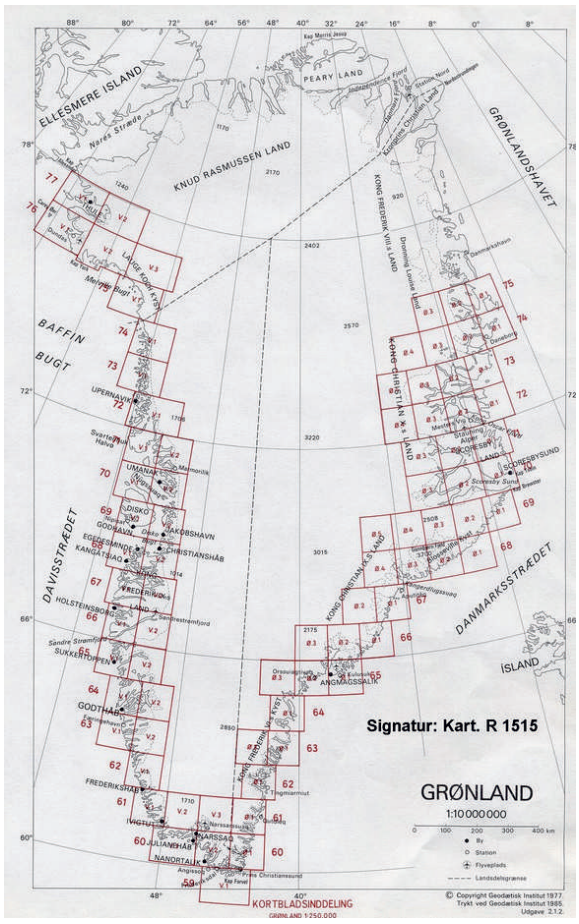
Appendix IV-9: Denmark -
1:25 000 mapping



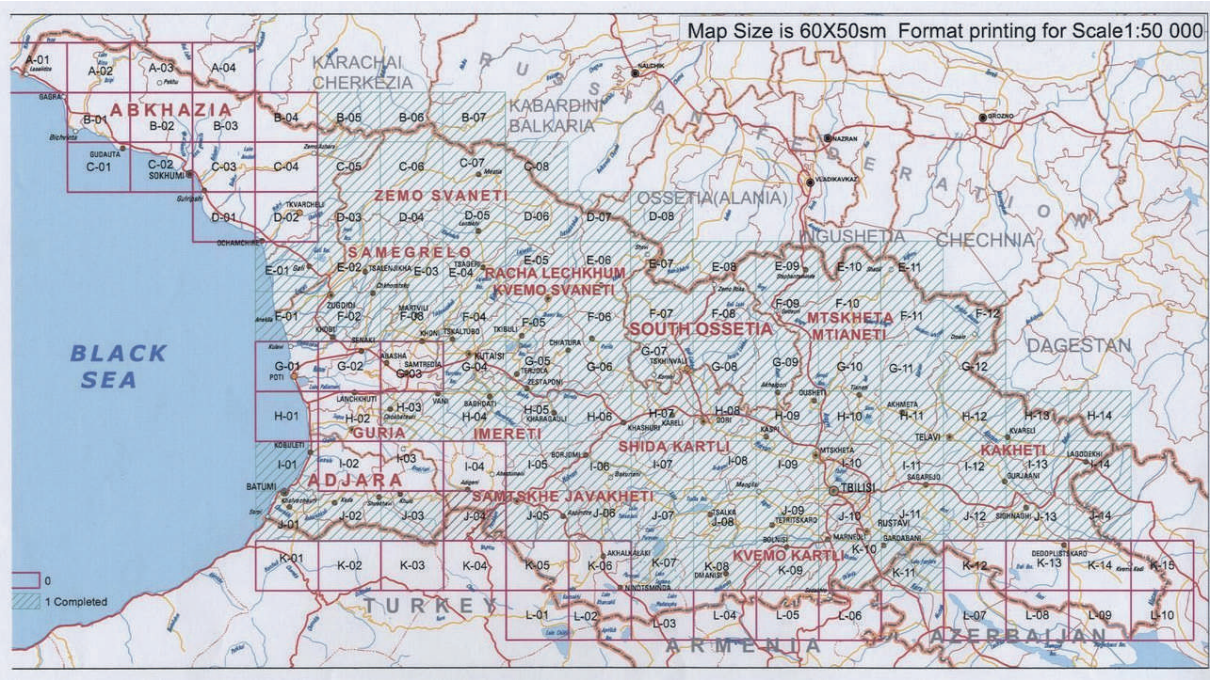
Appendix IV-10: Czech Republic - 1:10 000 mapping



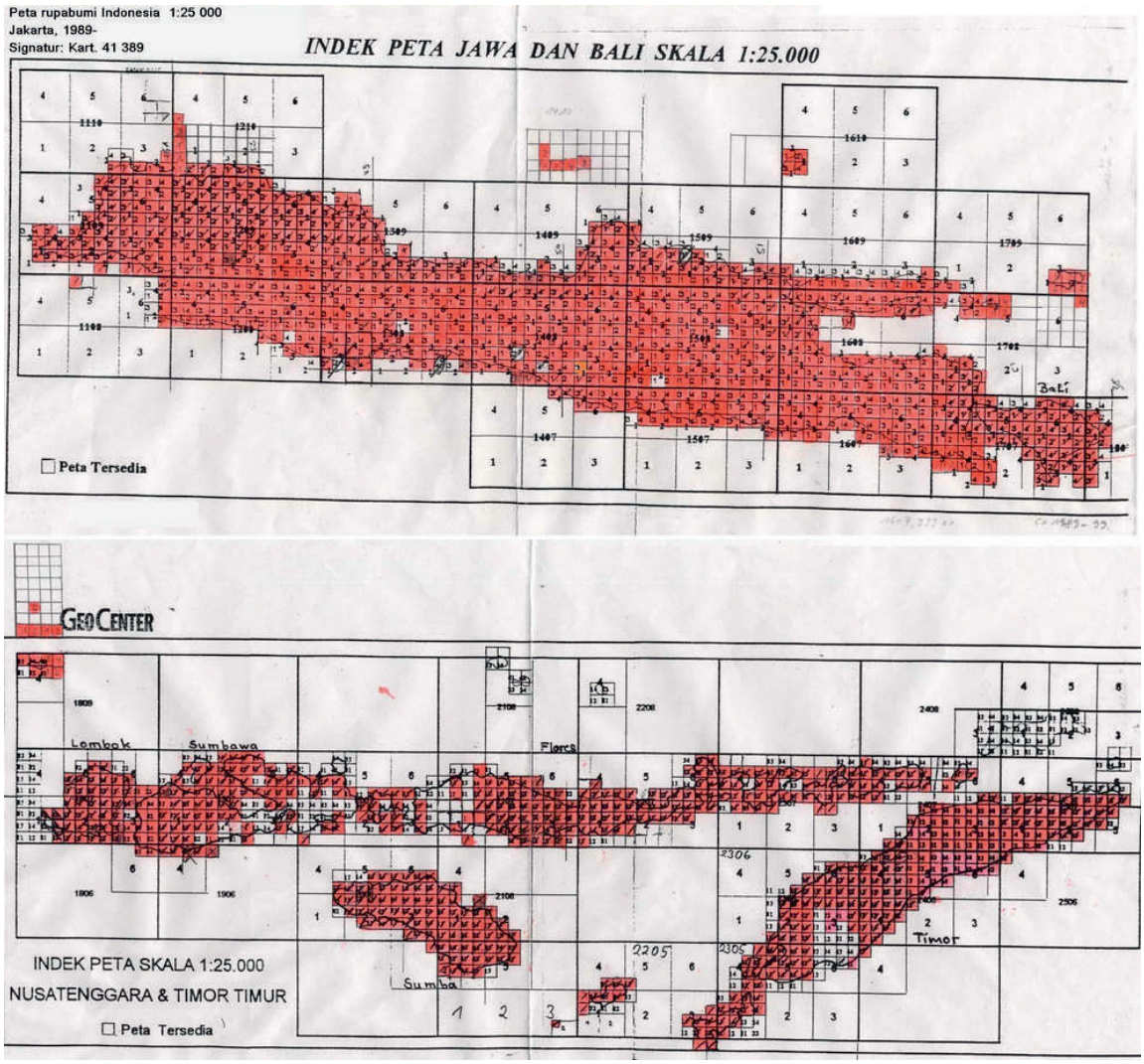
Appendix IV-11: Japan - 1:25 000 mapping



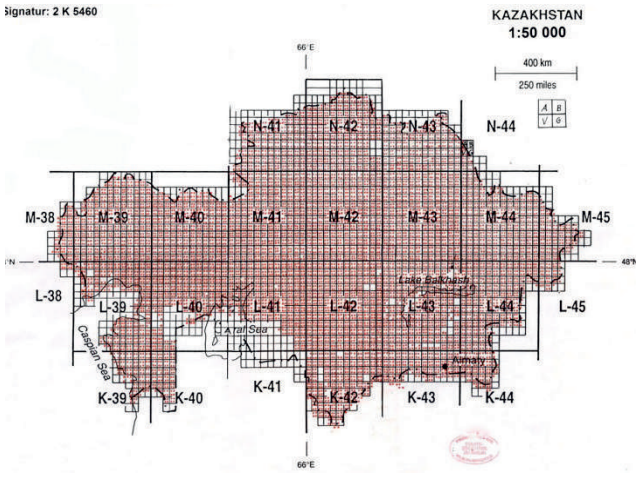
Appendix IV-12: Greenland - 1:250 000 coastal mapping



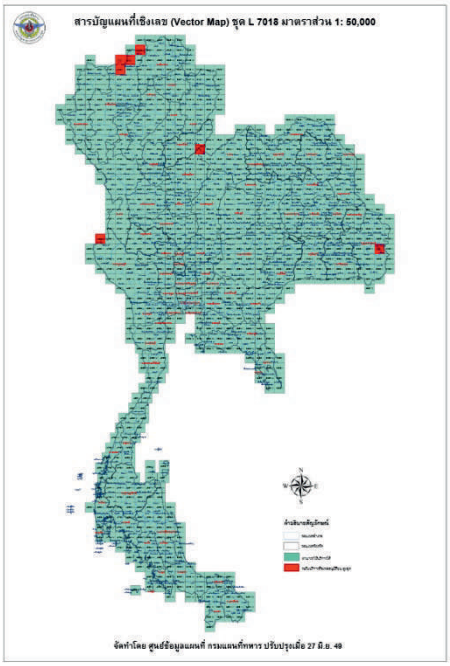
Appendix IV-13: Georgia - 1:50 000 mapping



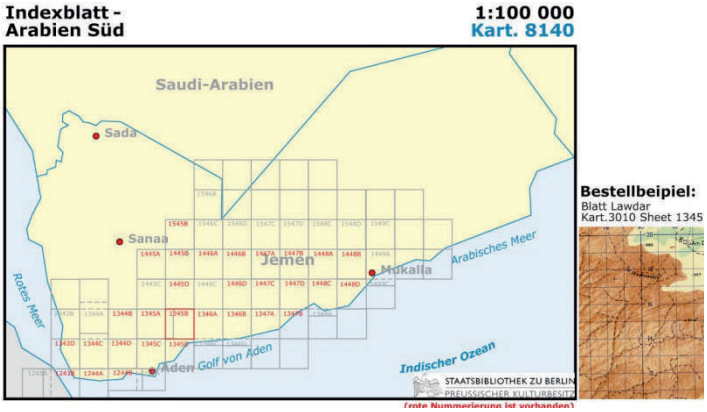
Appendix IV-14: Indonesia - 1:25 000 mapping of Java, Bali, Lombok and Timor



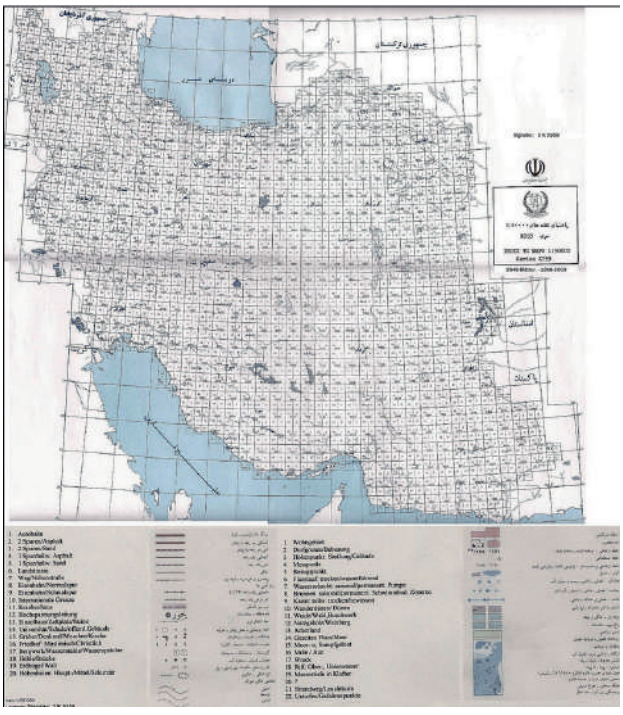
Appendix IV-17: Kazakhstan 1:50 000 mapping



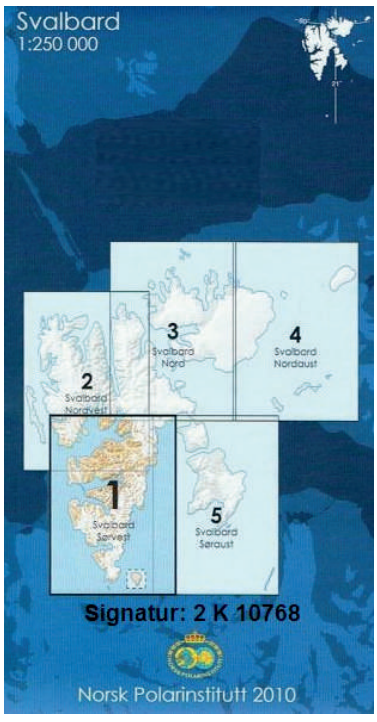
Appendix IV-15: Thailand, 2006 - 1 - 50 000 mapping



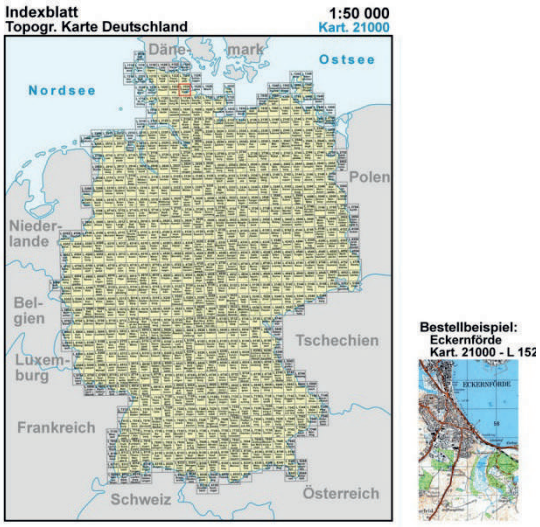
Appendix IV-16: Yemen - 1:100 000 Mapping



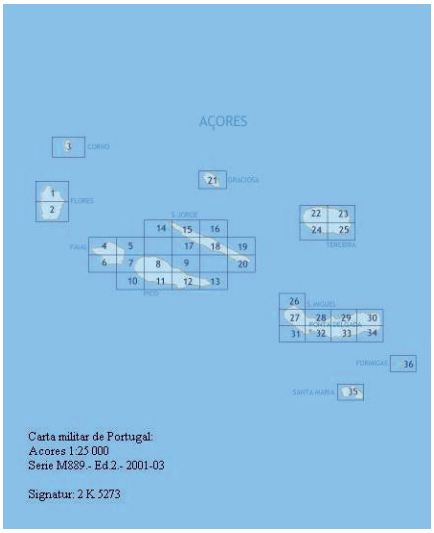
Appendix IV-18: Iran 1:50 000 mapping



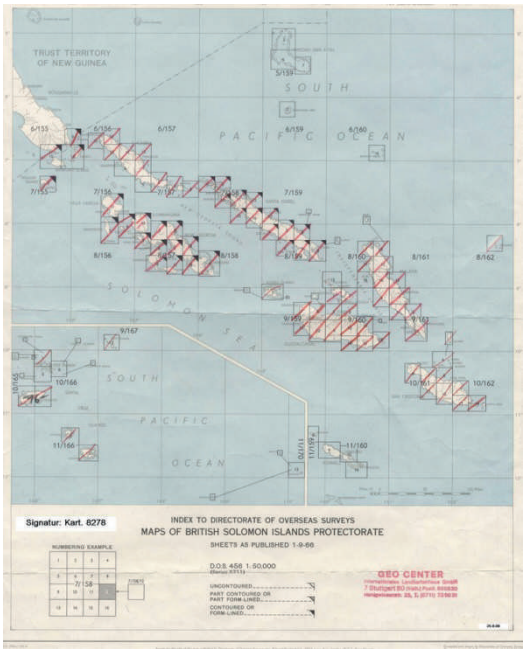
Appendix IV-19: Norway, Svalbard 1:250 000 mapping



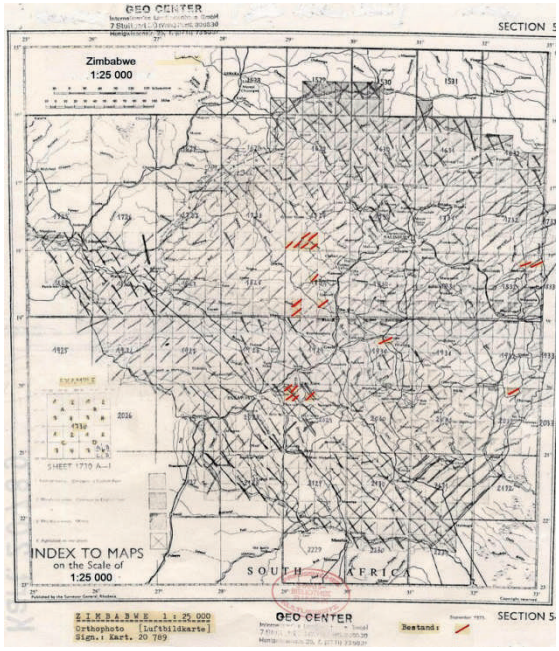
Appendix IV-20: Germany - 1:50 000 mapping



Appendix IV-21: Portugal-Acores - 1:25 000 mapping

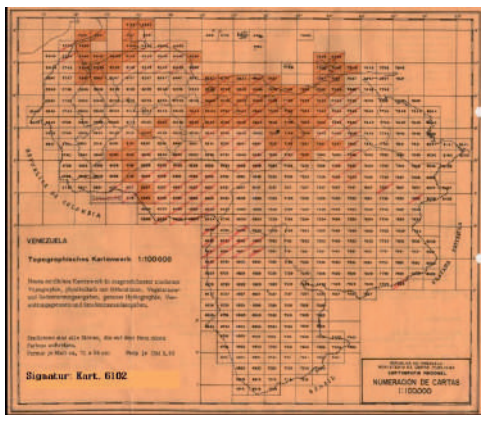


Appendix IV-22: Solomon Islands - 1:50 000 mapping

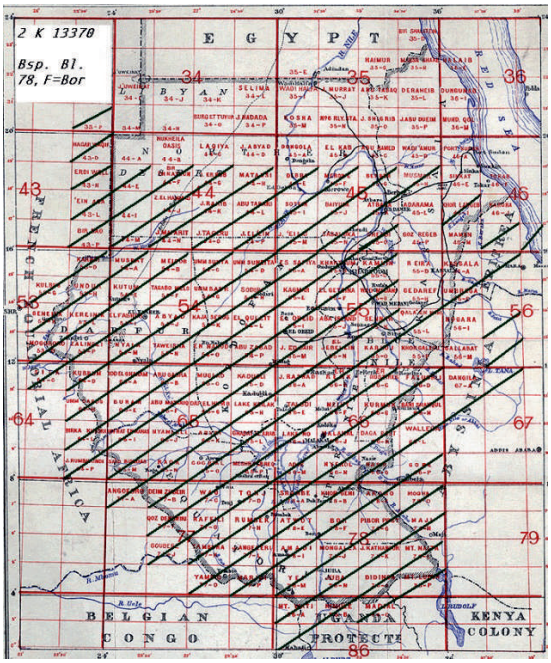


Appendix IV-23: Zimbabwe - 1:25 000 mapping

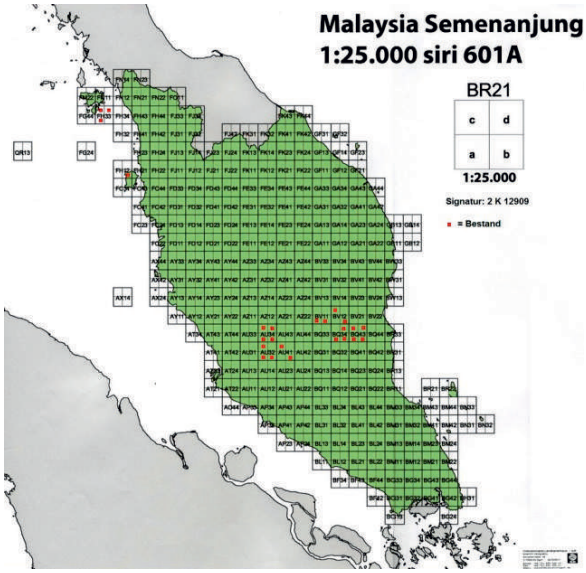
Appendix IV-24: Ukraine - 1:100 000 mapping



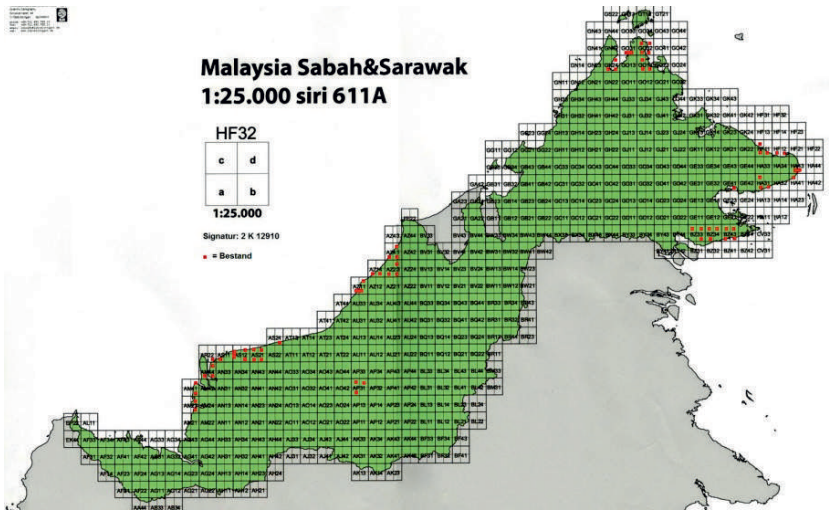
Appendix IV-25: Venezuela - 1:100 000 mapping



Appendix IV-26: Sudan - 1:200 000 mapping



Appendix IV-27: Malaysia - 1:25 000 mapping (Malacca)



Appendix IV-28: Malaysia - 1:25 000 mapping (Sabah & Sarawak)

Various project results can be viewed online as an interactive map at:

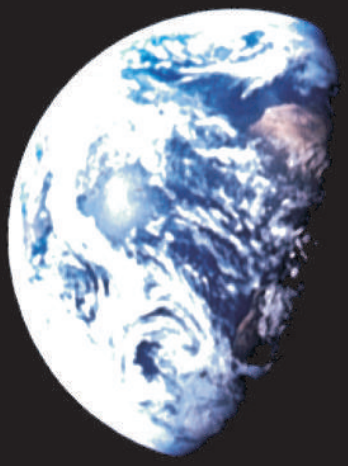
http://www.ipi.uni-hannover.de/StatusOfWorldMapping

Declaration regarding content of this publication:

The designations employed and the presentation of country or area names in this list do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations as well as the ISPRS and the authors concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Moreover the map used for illustrations of project results (Fig. 1 - 39) is only for the purpose of reference and the boundaries are not authorized by any organizations.

The source of the map is: http://www.naturalearthdata.com



JOINT PROJECT

UNGGIM - ISPRS 2012 - 2015

THE STATUS OF TOPOGRAPHIC MAPPING IN THE WORLD

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