

# IMPLEMENTATION OF A MANAGEMENT AND QUALITY CONTROL SYSTEM UNDER ISO STANDARDS 9001:2000, 19113, 19114,19138 AND 19115 IN CARTOGRAPHIC PRODUCTION

JOSELYN A. ROBLEDO CEBALLOS

[joselyn.robledo@saf.cl](mailto:joselyn.robledo@saf.cl)

GIANNINA L. REYES GATICA

[giannina.reyes@saf.cl](mailto:giannina.reyes@saf.cl)

## **SUMMARY**

### **INTRODUCTION**

Quality in cartographic production is generating a big revolution in the way of processing, manipulating, managing, and using the geographical information, since it covers all management and elaboration processes of cartographic products and their databases.

Nowadays, there is a great demand of geographical information in different areas since its use is not limited only to earth science experts. Problems emerge when the so called digital revolution occurs, which is the step to transform analogous maps in digital spatial databases, managed in computer software, what generates an absolute feeling of trust in the people who use these products, because they are more accessible, easy to handle and for generating other information from the original. Unfortunately, the fact that they are digitals does not guarantee the product quality. There are many factors that favor errors in the production and handling of geographical information such as: experts' and users' lack of knowledge, poor command of technical aspects, ignorance about databases genealogy, etc.

Then, one of the solutions to this kind of problems is to keep users of these cartographical products informed about the technical specifications of the product they are purchasing; or else, they will never be sure whether a result from geographical data handling is valid. But, how can we do this? This is the proposal that is set out in the development of this work, the generation of a model that allows to determine the quality of the cartographic products based on international standards such as ISO 9001:2000 and four standards of TC/211 ISO 19113, 19114, 19138 and 19115. These standards altogether permit obtaining an integrated quality management system which permits controlling, knowing, managing and informing about the quality and characteristics of the cartographic product.

## **METHODOLOGY**

This present study is based in the generation of an integrated system of quality using a base norm for this system through the quality Management (ISO 9001) and a specific group norms to the cartographic products (ISO 19113, ISO 19114, ISO 19138) that allow to determine its quality, using statistics reasonings and not personal appreciations, apart from informing this quality and enriching this product with useful data under an International language understood by everybody (ISO 19115: Metadata)

The previous implementation of the quality Management system in conformity with ISO 9001:2000 improves the Enterprise organizational aspects, because this norm proposes simple and proved principles to deliver products to satisfy users' requirements. The group of specific norms of Geographic information allows us to know the quality of the products through the definition and specification of qualitative and quantitative elements to measure the data quality. Finally, to deliver all the information about the product, by metadata reports, registering the main features and limitations for each product.

Finally, from all this, we can establish using as a base the implementation of ISO 9001 norm and over this system introduce the implementation of specific norms to the Geographic information, achieving the control of data quality and ensure users' satisfactions.

## **RESULTS**

The implementation of this integrated system of quality (quality integrated system) resulted in a hard task to put organizational aspects into order and the information itself, establishing actors and responsibilities in the generation of our cartographic products. The final proposal considers simple work guidelines on how to register processes for the generation for each product, to insert quality controls and report the results by metadata, keeping users under complete knowledge of the acquired product.

This proposal solves the problems generated by the lack of quality in the products and its associated costs, either for their use in institutions or companies that generate this data as well as for external users.

## **CONCLUSIONS**

With advanced technology and new market demands, Geographic information has become a fundamental pillar (support) in making decisions for different matters related to geographic activities, economic and human, among others, contributing to the

sustainable development of the nations. For this reason, the implementation of specific norms for cartographic products has become a priority to start with good practices in these areas and having reliable and quality information by the time of making a decision, for the result be a real contribution for people's economic and social welfare.

The implementation of these norms is not a simple task when there are no national implementation references (guidelines), because these are generic and demand time for their study, apart from the analysis of the critical points in every level of the process of the product, to –then- design a work methodology. To ensure the correct practice of these norms, it is important to have as a base a quality management system in conformity with ISO 9001, thinking of it as a support for the management and the right practice of CT/211 norms more than an obligation.

Metadata generation is also important in this development because it allows knowing our own products in detail, and to share this information with the users, benefiting a better taking decision process. All of this is part of one of the fundamental pillars for the creation of map navigators that count with Intelligent Search Systems, information filters and interaction between Geographic data, which is it the base for the creation of a special data infrastructure.

# IMPLEMENTATION OF A MANAGEMENT AND QUALITY CONTROL SYSTEM UNDER ISO STANDARDS 9001:2000, 19113, 19114,19138 AND 19115 IN CARTOGRAPHIC PRODUCTION

JOSELYN A. ROBLEDO CEBALLOS

[joselyn.robledo@saf.cl](mailto:joselyn.robledo@saf.cl)

GIANNINA L. REYES GATICA

[giannina.reyes@saf.cl](mailto:giannina.reyes@saf.cl)

## INTRODUCTION

Nowadays, to speak about quality in the main institutes or cartographic services in the country is quite common. There is national commotion to be acknowledged or certified under an international standard which allows positioning the company in the market and guaranteeing the customers quality products. The geographical information field has a long way to go given that the control of processes that ISO 9001:2000 proposes is not enough, more specific standards that permit to standardize and control the quality of the geographical information from the genesis to the end of the cartographical product are needed. These specific standards correspond to those developed by TC/211, what covers subject matters such as: general, service, raster-grid data and supplementary standards.

The current work is exclusively focused on the standards that have a direct relationship with the quality control of the geographical information and the proper delivery of this information. But, how can we do this? Even knowing that this is true, there are many ways to do it and it will depend on the organization and its resources. In view of the previous, a methodology of implementation of a Quality Management System under ISO 9001:2000 is proposed together with ISO Standards 19113, 19114, 19138 and 19115, generating a work plan for their implementation.

Implementing is quite a complex work if it is taken into account that standards are generic, that they must be studied, understood and adapted to the reality of every organization, generating methodologies appropriate to each of the products; moreover, professionals in the area must be persuaded of the social and economic importance of controlling the quality of the geographical information, the need to invest in human, technological and financial resources, considering the maintenance and continual improvement through time of the Management Integrated System and Control of Quality. At present in the Servicio Aerofotogramétrico (Aerophotogrametric Service) this system is being implemented, based on ISO 9001:2000 certification, incorporating the standards that are related with the geographical information quality to certified processes. But, how is this system implemented? What should be considered? These are the questions that this work expects to answer, delivering a practice implementation guide based in the experience acquired. The main interest is contributing by means of

this knowledge to the sustainable development of the country, by providing tools that permit generating geographical information of quality facilitating decision making both at the state and private level.

## **OBJECTIVE**

- Deliver an implementation model of 19113, 19114, 19138 and 19115 ISO standards, to promote the application of these in cartographic production.

## **METHODOLOGY**

There are few references in respect to the implementation of TC/211 Standards here in Chile, but there are various experiences from other standards related with quality management, the environment and social security. These Standards cover different thematic and are inter-related to achieve a common objective: generate a Quality Management Integrated System, what takes us to the total quality concept. As there is not yet a certifiable standard within the 211 Technical Committee, it is necessary to implement a Quality Management Integrated System that includes the Quality and Metadata Standards for cartographic products, and ISO 9001:2000 as the system basis, thus allowing to control the processes and assure the final product quality. Counting on an ISO 9001:2000 certified Quality Management System facilitates implementation of any non certifiable specific standard allowing to control compliance of its requirements within the productive processes.

Standards related with geographical data quality are:

- ISO 19113 Standard: Quality Principles.

This Standard indicates that there are qualitative and quantitative elements (refer to table n°1) in order to measure the quality of the geographical data, its definitions and specifications. The applicability of these elements will depend on the product characteristics, on the human, technical, and technological resources, what implies carrying out feasibility studies to determine the most efficient and efficacious way of implementing the standard.

| Quality Elements and Sub-elements |                         |  |
|-----------------------------------|-------------------------|--|
| Qualitative Elements              | Use, Purpose, Genealogy |  |
| Quantitative Elements             | <b>Element</b>          | <b>Sub-element</b>   |
|                                   | Positional Accuracy     | Absolute, Relative   |
|                                   | Completeness            | Omission, Commission   |
| Quantitative Elements             | <b>Element</b>          | <b>Sub-element</b>   |
|                                   | Logical Consistency     | Topological, Format, Conceptual, Command.  |
|                                   | Temporal accuracy       | A Measure of time Exactness, Temporal consistency, Temporal Validity.  |
|                                   | Thematic Accuracy       | Correction of Classification, Correction of non quantitative attributes, Accuracy of Quantitative Attributes |

Table n° 1 Elements and Sub-elements

-ISO 19114 Standard: Quality Evaluation Procedures.

This Standard refers to quality evaluation procedures, establishing for it a standard process that shall be complied with both with and without quality specifications available. For this standard, quality evaluation consists of obtaining an index (-es) of the product quality. This indication may be quantitative or not. Table n° 2 specifies the proposed process steps.

| Process step | Action   | Description   |
|--------------|--|---|
| 1            | Identify an applicable data quality element, data quality subelement, and data quality scope | The data quality element, data quality subelement, and data quality scope to be tested shall be identified in accordance with the requirements of ISO 19113. This is repeated for as many different tests as required by the product specification or user requirements.  |
| 2            | Identify a data quality measure  | A data quality measure, data quality value type and, if applicable, a data quality value unit shall be identified for each test to be performed. Annex D provides examples of data quality measures for the data quality elements and data quality subelements given in ISO 19113. Annex D, by these examples, provides assistance to the user in selection of a measure. |
| 3            | Select and apply a data quality evaluation method  | A data quality evaluation method for each identified data quality measure shall be selected.<br><br>NOTE A spatial description of the results, e.g., achievable by spatial interpolation of the results, graphical portrayal, etc.) might be useful, corresponding not to a result, but to a different, although related, dataset.  |
| 4            | Determine the data quality result  | A quantitative data quality result, a data quality value or set of data quality values, a data quality value unit and a date is the output of applying the method.  |
| 5            | Determine conformance  | Whenever a conformance quality level has been specified in the product specification or user requirements, the data quality result is compared with it to determine conformance. A conformance data quality result (pass-fail) is the comparison of the quantitative data quality result with a conformance quality level.  |

Table n° 2 Steps for quality evaluation according to ISO 19114

- ISO 19138 Standard: Measurement of the data quality

This Standard proposes Standardizing the quality measure to be applied to geographical information, utilizing a set of measures that are known and easily interpreted both by users and by producers. These quality measures may be utilized to report data quality and their choice depends on the type of data and their purpose.

The implementation of these three Standards allows for the regulation of aspects relative to the evaluation and description of the Geographical Information quality, thus avoiding ambiguous information and facilitating the adequate choice and use of the products. These standards seek full understanding between producers and users of this kind of information, favoring their commercialization, spread and efficient use.

**IMPLEMENTATION PROBLEMS**

Currently in Chile these Standards may be found in their original version. There is not an official translation for the country, reason why their application requires a previous translation and support in foreign homologation (UNE Standards in Spain and NTC in Colombia). Every Standard has a generic character, provides guidelines and implementation demands, plus requirements of conformance of the same, but does not show the method to achieve it because each product requires a special treatment that adjusts to its needs, to comply with its technical specifications. Additionally, it is necessary to understand the relationship between these Standards to be able to measure and control the quality of the product. Figure n°1 presents interaction between quality Standards (ISO 19113 and 19114) and metadata (ISO 19115), including also reference to other Standards defined for evaluation methods and technical specifications of the product (ISO 2859, 3159 and 19131).

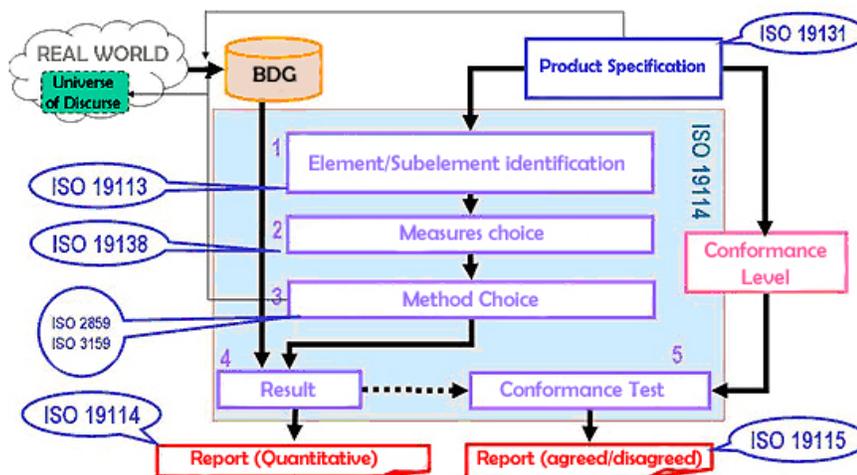


Fig. n°1: Interaction between Standards; Source: Standards about quality in geographical information (ISO 19113, ISO 19114, ISO 19138). Francisco J. Ariza.

## **EVALUATION OF QUALITY**

The cartographic product must be identified and to be evaluated, which should count on clearly defined technical specifications,. This allows establishing acceptance parameters and levels of conformance in accordance with these ones. Having concrete procedures, written and detailed by stages for the product generation, allows detecting points where deviations arise blocking the achievement of the established specifications, correcting errors in time and with this background information determining if necessary modification of the procedure to improve the results

As a part of the improvement of the product, the TC/211 Quality Standards propose evaluating and controlling quality by means of application of elements and sub-elements. According to the product characteristics, applicable elements described by ISO 19113, and respective sub-elements, are determined, for it, feasibility of its application should be considered, since it is necessary to count on sufficient human, economic and technological resources for this task. At least one evaluation measure for each sub-element must be established, which shall be informed and recorded according to ISO 19138, plus the evaluation method for this sub-element, the type of result and the parameters of acceptance of such results that allow carrying out the product test of conformance. The principal methods used for evaluating quality of a product are based on descriptive statistics, what provides the necessary reliability for guaranteeing the final product quality. All this quality information on quality may be reported as a quantitative report according to ISO 19114 and as a conformance report according to ISO 19115. Figure n°2 explains what has been mentioned by means of a scheme representing the application of the elements of Quality, Position Accuracy, Completeness, and Logic Consistency.

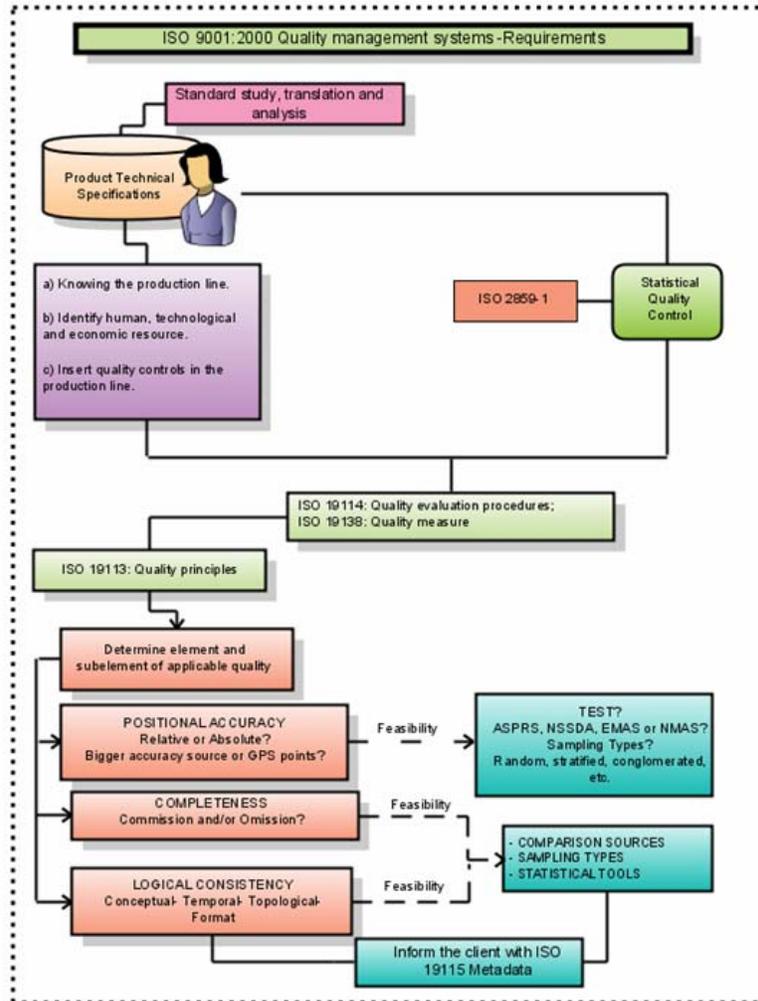


Figure n° 2 Proposal of implementation of the Standards

## METADATA

Norm ISO 19115 provides a structure describing Geographic data documenting the main characteristics and limitations of the Geographic product. Once the processes and controls allowing the generation of a product that fits with the expected design and specifications are developed, we can register this information in a metadata that in compliance and conformity with this norm, composed by one or more metadata sections (UML packs) that contain one or more metadata entities (UML types).

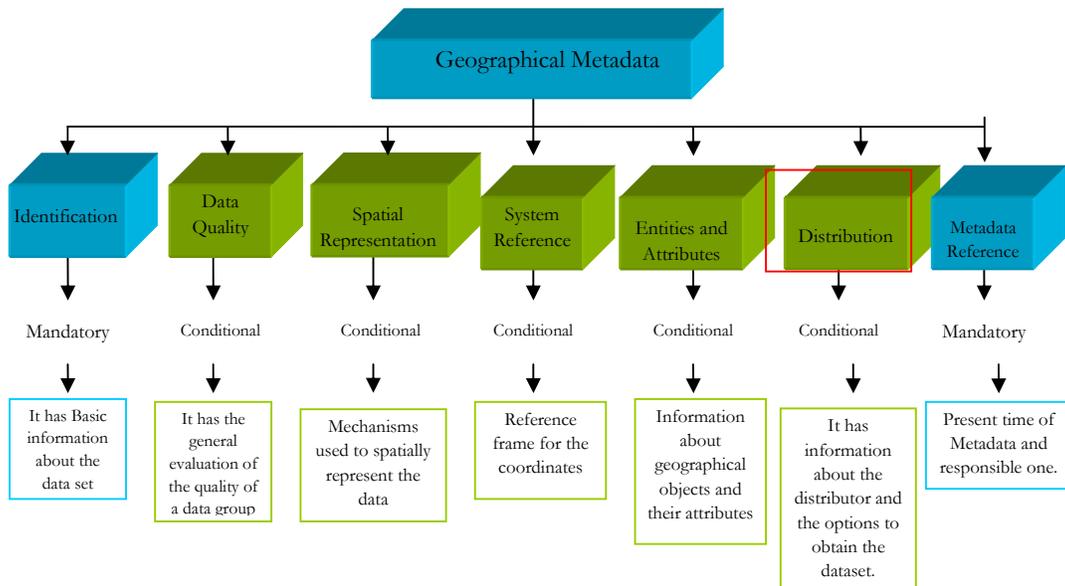


Figure n° 3 Structure of geographical metadata, conformance level 2

The development of the structure chosen to report the information of the geographical data depends on the conformance level wanted to be established and product inherent characteristics. There is a kind of free software that permits to comply with this standard, in the case of not having resources to generate a metadata system that satisfies the company needs and the products generated. If processes optimization is considered, it is necessary to implement and adapt this standard to the inherent requirements of the company, including added data that do not appear in the structure proposed in case of being of vital importance, besides the data input through the production line with the objective that the product metadata is totally entered at the same time when the production ends.

At present, the Aerophotogrametric Service of the Air Force of Chile has a software with these characteristics called Data SAF. Initially, this software was designed to

generate metadata of a specific product, Aero-nautics Cartography with data added according to its requirements, permitting the delivery of all the needed information and of vital importance to the users of this type of cartography. In addition, it is in a period of constant updating and adaptation for the other products that the Service generates and in permanent evaluation to adjust to the international guidelines, regarding metadata.

Figure N° 4 shows the data input window of the DataSAF software quality item. On the left, the menu is framed that has the different items that make up a geographical metadata for the input of the corresponding data.

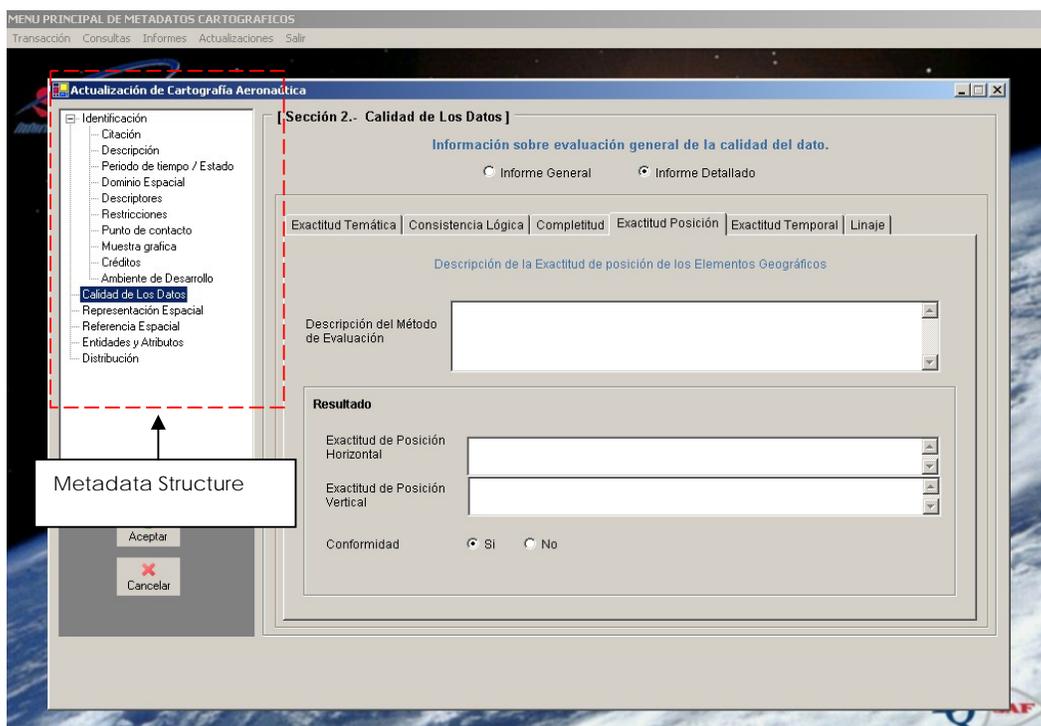


Fig. N° 4 Data SAF Software quality section

At the international level, there is a big development of the metadata for cartographical products, but there is little control about the quality of these products yet, reason why this item is still, in some cases, without data input, due to the complexity that the development of a quality control model implies. The Aerophotogrametric Service has a quality control model in force for Aeronautic Cartography product and it is in the process of validation for their other products.

## RESULTS

The experience acquired during the implementation process of quality standards of TC/211 permits to analyze the application difficulties, pose different solutions until finding the most appropriate and that effectively resolves the errors in processes and delivery of geographical data. With the tools that these standards provide the product generation can be optimized, given that the elaboration process of these is deeply known, the information sources used and previous treatments associated to these sources. It is worth mentioning that the previous implementation of an ISO 9001:2000 Quality Management System favors the implementation and maintenance of a quality evaluation model of ISO 19100 family standards, achieving what has been called a Management Integrated System.

The Implementation Model finally proposed is as follows:

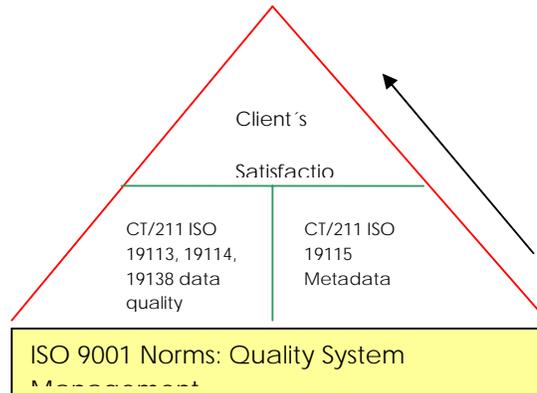


Figure N° 5 Implementation and results pyramid, Source: own elaboration.

- Use ISO 9001:2000 Quality Management System as a basis.
- Define the product to be performed characteristics and technical specifications.
- Design the product generation model.
- Determine quality elements and sub-elements applicable in conformance with ISO 19113.
- Establish the methodology for evaluating quality according to ISO 19114.
- Define and record quality measurements for every sub-element in conformance with ISO 19138.

- Insert in the product generation model the quality evaluation processes to the corresponding stage, document it and incorporate it into the Quality Management System.
- Structure the required metadata for the product in conformance with ISO 19115 and report it to the users.

## CONCLUSIONS

Nowadays, the implementation of standards that permit controlling and assuring the cartographical product quality must be one of the main tasks for cartographical institutions and companies, since the geospatial information has gone beyond its value and expanded its uses and applications further than the geographical scope, it is also used in various subject matter areas as a basis of the already known geographical information systems focused on medicine, sales, engineering, among others.

Implement these standards is an arduous work. It must have technological and economic resources, as well as personnel constantly devoted to this activity, apart from motivating the change among professionals and institution leaders in the traditional way to generate cartographical products.

The advantages of implementing this system are:

1. The producer knows the quality of the product generated.
2. so that the advantages and disadvantages of the product are determined, being able to quickly detect and correct deviations and plan in an efficient way constant improvement of the processes.
2. By means of the generated metadata from the structure proposed by ISO 19115, completed and detailed information about the processes that have taken part in its generation can be provided to customers and statistical controls that guarantee the product quality or, at least, announce the characteristics that the product has, granting the user the freedom to choose whether the product quality adapts to their requirements or personal use.
3. Implementation of these management and quality control systems permit the company to reduce the costs in the medium and long term due to lack of cartographic products.

Finally, if we deliver geographical information of quality we are giving the leaders the ability to make better decisions contributing in this way to the country sustainable development. I

## **BIBLIOGRAPHY**

- ISO (2002). ISO 19113: Geographic Information – Quality principles. International Standardization Organization. ISO TC/211 Secretariat, Majorstua, Norway.
- ISO (2003). ISO 19114: Geographic Information – Quality evaluation procedures. International Standardization Organization. Geneve, Switzerland.
- ISO (2005). ISO 19138: Geographic Information – Data quality measures . International Standardization Organization. ISO TC/211 Secretariat, Majorstua, Norway
- ISO (2003). ISO 19115: Geographic Information – Metadata. International Standardization Organization. Ginebra, Suiza
- NCh ISO (2000). ISO 9001: Sistema de Gestión de Calidad-Requisitos, Santiago, Chile.
- Ariza, F., (2002) Calidad en la producción cartográfica. Primera edición, España.
- Ariza, F., (2004) Casos prácticos de calidad en la producción cartográfica. Primera edición, España. Universidad de Jaén.