Monitoring of Spatial Data Infrastructures

An evaluation of approaches

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Abstract

SDI monitoring and evaluation is increasingly attracting the attention of both public sector bureaucrats seeking justification for providing public sources to SDI and SDI practitioners requiring a measure of success of their SDI strategy. In recent years, a shift from an intuitive to more rational SDI assessments can be observed. SDI monitoring and evaluation is becoming operational and is already part of some SDI implementations and practices. Based on an analysis of the operational monitoring systems of the Dutch national SDI (GIDEON), the European SDI (INSPIRE) and the Catalan SDI (IDEC). We describe, analyze and compare comprehensively the design and application of operational SDI monitoring systems and identify common issues to be taken into account for monitoring of SDIs. This can support further improvement of evaluation practices and operational setups of SDI monitoring systems.

KEYWORDS

Spatial Data Infrastructure, Monitoring, Evaluation, INSPIRE.

1. INTRODUCTION

Spatial Data Infrastructure (SDI) is about the facilitation and coordination of the exchange and sharing of spatial data between stakeholders in the spatial data community. The aim of SDIs is to organize and make information available and accessible and include the technology, policies, standards, human resources, and related activities necessary to support its goals. Since the beginning of the nineties many local governments, countries, and regions have been building Spatial Data Infrastructures (SDIs) [1],[2],[3]. It is believed that through well established and properly functioning SDIs general economic, social and environmental benefits can be realized [4]. SDIs have the potential to spatially enable governments by providing better service to decision-makers, politicians and societies. Large sums of money have been invested in SDI initiatives over the last few years Worldwide around €120 million each year is spent just on clearinghouse management [5]. The investment requirements for an Infrastructure for Spatial Information in the European Community (INSPIRE) at the European, national, regional and local levels is estimated to be from €202 to €273 million each year [6]. Given this expenditure and society's interest in the proper and effective use of public funds, it is imperative that these SDI initiatives should be monitored and evaluated.

Monitoring can be described as being aware of the state of a system and be able to observe changes with may occur over time. Based on observation from monitoring systems and defined criteria and standards assessments or evaluations can be made. They are used to understand and improve the evaluated object and/or summarizing, describing and judging its outcomes [7]. Hansen [8] presents a typology and classification of several evaluation models. They differ in the questions that they aim to answer and the evaluation criteria they use, e.g. the result model focuses on goal realization and effects, the explanatory process model on level of activity and implementation and economic model on cost-efficiency, cost-effectiveness or cost-benefit aspects. Monitoring and evaluation often serve as basis for decision-making about policies and implementation issues. To assure an acceptable level of quality, prove its validity and earning credibility among the potential users also the evaluation process needs to be evaluated [9]. The concept of evaluating the evaluation is also named meta-evaluation. The aim is to document strengths and weaknesses of the evaluation process with the purpose of improving evaluation practices.

SDI monitoring and assessment is increasingly attracting the attention of both public sector bureaucrats seeking justification for providing public sources to SDI and SDI practitioners requiring a measure of success of their SDI strategy. An extensive body of SDI assessment literature already exists. Many authors have proposed assessment views to assess SDIs [10],[11],[12],[13]. The majority of them were proposed within the SDI scientific community. The character of these studies was rather intuitive and curiosity-driven. Their aim was to explore and build knowledge about the performance and benefits of SDI. These studies were natural in the early stage of SDI development when knowledge about SDI was limited. However, in recent years, a shift from an intuitive to more rational SDI assessments can be observed [14]. SDI monitoring and evaluation is becoming operational and is already part of some SDI implementations and practices. Grus et al. [9] proposed a method to assess the extent to which SDIs realize their goals based on measurable and scalable indicators. The method is operational

and has been implemented for the vision and implementation strategy of the SDI in the Netherlands, known as GIDEON. The INSPIRE directive requires from the member states a continuous monitoring of the implementation with respect to the targets set out by INSPIRE and a three yearly report describing the approach of the member state for implementing INSPIRE and the developments of its SDI [15]. To monitor and evaluate the development of the Catalan SDI, known as IDEC, a system based on target values has been designed and implemented over a three year period, from 2006-2008 [16].

However, little is known about how operational SDI monitoring systems are designed, applied and used in SDI practices. To improve evaluation practices and operational setups of SDI monitoring systems we describe, analyze and compare comprehensively the design and application of operational SDI monitoring systems and identify common issues to be taken into account for monitoring SDIs. The remainder of this paper is organized as follows. The method used is described in section 2. The case studies and the results of our analysis are described in section 3. In section 4 the results and their implications for SDI monitoring are discussed.

2. METHOD

2.1 FRAMEWORK OF COMPARISON

To systematically compare SDI monitoring systems a comprehensive framework for comparison is needed. Rajabifard et al. [17] identify five core SDI components common to most SDI implementations: 1) people; 2) technology; 3) policy; 4) standards and 5) spatial data. They can be considered as the building blocks of the SDI and therefore as subject of SDI monitoring systems and can be used to structure collected information. For example the INSPIRE state of play reports use SDI component to monitor the development of 32 National SDIs in Europe [18]. Crompvoets et al. [19] use the SDI components as comprehensive frame to describe quantitatively and qualitatively the development of national clearinghouses. Also others have used SDI components to describe and monitor SDI developments [10], [20]. Based on [5],[17],[18] table 1 describes the components and potential indicators to measure the components. In our analysis we use the components as framework of analysis to group and structure indicators used in SDI monitoring systems.

Table 1: framework of comparison: the five SDI components and indicators to describe them.

Component	Description of component	Examples of indicators to describe component
People (Users base)	Data suppliers, managers, end-users and others involved in SDI activities	Number of stakeholders, Number of end-users, Number of downloads, Number of visitors
Technology	Services, software and hardware facilitating the access to and use of data	Software and tools used, Availability of download – and mapping services
Policy (administrative)	Financial and organizational framework and policies and guidelines for data and standards	Legal framework, Funding model, Type of SDI coordination, Registration policy, Type of data sharing arrangements
Standards	Standards for data models, data services, and metadata to ensure interoperability amongst the datasets and access mechanisms	Indicators for the application of: Standards for metadata, Data, and Services
Data	Content of an SDI e.g. the thematic content, the data types, the data formatss	Number of metadata records, Number of available data sets, Thematic data content, Geographic extent

The monitoring organization and application are also subject of our analysis. There for additionally to the five core components we analyzed a number of organizational issues. We based our approach on the INSPIRE state of play reports, which also includes indicators for organizational issues [18], [20]. Table 2 describes the organizational issues to compare the SDI monitoring systems.

Table 2. Organizational issues: the coordination, participation and operationally of monitoring systems

Organisational issue	Description	Examples of issues
Coordination	Coordination and organization of the monitoring	Responsible authority, Organization of coordination, Procedures, Policy or legal framework
Participation	Participation of stakeholders in the process	Participation in: setting up system, Providing data, Reporting
Operationally	Application of the monitoring systems	First application, Frequency of monitoring, Methods used for data collection

2.2 CASE STUDIES AND DATA COLLECTION

Our analysis is based on a case study approach to empirical analyze and compare the design and application of operational SDI monitoring systems. Only a few SDI monitoring systems are operational and have been practical applied for SDI implementations. We identified three more or less operational SDI monitoring systems: the Dutch NSDI (GIDEON); the European SDI (INSPIRE;) the regional SDI of Catalonia (IDEC). All case studies use indicators with target values and monitor the progress of SDI implementations overtime. In the typology of Hansen [8] they can be classified as a goal attained model measuring to what degree goals are realized. Therefore we consider them as being comparable. Information describing the method and procedures of the SDI monitoring was available for all three case studies. The three operation monitoring systems have been analyzed using policy and research publications, [21], [9] for GIDEON, [16] for IDEC and [15], [22] for INSPIRE. Based on this information the case studies have been described and the indicators used to describe the SDIs are being identified and grouped by the five SDI components. Subsequently the three SDI monitoring systems are being analyzed and compared on the organizational issues: coordination, participation of stakeholders and the operationally of the SDI monitoring. Based on the analysis of the three monitoring systems common issues to be taken into account monitoring and evaluating are being discussed.

3. RESULTS

3.1 CASE STUDY DESCRIPTION

GIDEON

Since 2008, the Dutch SDI is being constructed by implementing the vision and strategic plan called GIDEON [23]. GIDEON establishes 4 goals that need to be realized by 2011. The implementation process is coordinated by the Ministry of Housing, Spatial Planning and the Environment (VROM), which is the formal coordinator of the Dutch SDI. The GI council is acting as the steering committee for the implementation of GIDEON. The GI council has representatives of all important governmental SDI stakeholders, and in its role as steering committee, it creates conditions for GIDEON implementation and monitors progress and consistency in its implementation. Geonovum is the SDI coordination body and is supporting VROM in its coordination role by monitoring the progress of GIDEON and reporting to the GI-Council. In its role as formal coordinator VROM requested in 2009 monitoring of the extent to which the 4 GIDEON goals have been realized, as part of the progress monitoring carried out since 2008 by Geonovum [21]. Together with the SDI stakeholders Geonovum and Wageningen Univerisity developed, applied and evaluated an assessment view for evaluating the extent to which SDIs realize their goals based on indicators. The assessment view has been developed stepwise using the Multi-view SDI assessment framework as a guideline. A long list of 72 potential indicators was compiled. As a basis for collecting the potential indicators, indicators from four assessment approaches of the Multi-view SDI assessment framework have been used [9]. In a one day workshop the participants selected from the long list those indicators the ones which, according to them, would best measure the realization of the goals of GIDEON. The final selection of indicators was done by experts reviewing and assessing each indicator on characteristics of SMART (Specific, Measurable, Achievable, Relevant and Time) indicators. An extensive description of this stepwise approach can be found in [9]. In the annex of this paper the four GIDEON goals and the selected indicators to measure the goal realization are included.

INSPIRE

The INSPIRE Directive (2007/2/EC) of the European Parliament and of the Council of 14 March 2007 established an Infrastructure for Spatial Information in the European Community (INSPIRE). According to the Directive, Member States shall organise “a continuous monitoring of the implementation progress with respect to the

targets set out by INSPIRE" and provide "a three yearly report to the Commission to describe the approach applied by the Member States to translate the requirements set out by INSPIRE into concrete measures and describe the developments of its SDI". Member States will provide the results of the monitoring and reporting to the Commission and make them accessible to the public. The mechanism assesses progress as compared to the rules and requirements set out in the Directive and its Implementing Rules. The INSPIRE monitoring system has been based on the requirements of the INSPIRE directive and has been worked out in implementing rules (IR). The drafting team on monitoring and reporting, a team with international experts from different EU member states selected by the European Commission, has developed those IR together with the INSPIRE stakeholders, who had the possibility to comment on drafts in several consultation rounds [22]. The final version of the IR for monitoring and reporting have been approved on 5th of June 2009 and from then on member states are obliged to continuously monitor 8 indicators, focused on monitoring the progress made in regards to metadata, data interoperability and service development. Monitoring is covering a calendar year, and shall be published by the 15th of May of the following year. Every three years member states need to report in standardized reporting format on 5 other items describing the use and implementation of the infrastructure [15]. The first reports should have been made available 15th may 2010. In the annex of this paper the 8 indicators and the 5 items are included.

IDEC

On December 27th 2005, the Geographic Information Law, assigned to role of coordinator for the Catalonia's Spatial Data Infrastructure (IDEC) to the "Institut Cartogràfic". Part of the legally obligatory coordination activities is monitoring of the development of IDEC and evaluate if it functions in accordance with regulations. In 2007 the IDEC support centre started developing a monitoring system to evaluate de development and activities of IDEC. The monitoring system has been used to analyse the IDEC development from 2006 to 2008. The results have been reported on in the annual report for the ´Comisión de Coordinación Cartográfica de Catalunya´. To set up the monitoring system first five elements to be monitored have been defined and weights have been assigned to the elements. Subsequently for each element indicators have been defined, partly based on the indicators used for the monitoring of the INSPIRE directive. For each individual indicator a maximum value and weight has been defined. Each year the results obtained in the considered year are measured and the result is divided by the target's maximum. On basis of the indicators values, the weights of the indicators, the weight of each element an index is calculated for the year [16]. The system has been applied by the IDEC support centre for the years 2006, 2007 and 2008. The five elements and the indicators defined for each element can be found in the annex. An extensive description of the weighs assigned to the elements and indicators and the calculation procedures can be found in [16].

3.2 ANALYSIS OF INDICATORS

Table 3 gives an overview of the indicators used in the three SDI monitoring systems grouped by SDI component. The numbers in the tables correspond with the numbers assigned in the Annex of this paper. Here a full description of each indicator can be found. For each SDI component (policy, technology, standards, data and people) the results are further analyzed and discussed.

People

In GIDEON 8 out of the total 12 indicators for INSPIRE 3 out of 13 and for IDEC 12 out of 22 monitor people or the user base of the SDI. All monitor systems measure the number of users of services. They also measure the level of cooperation and activity (GIDEON), involvement (INSPIRE) or participation (IDEC). GIDEON also uses several indicators to measure the economic development. IDEC also monitors the number departments and municipalities providing and giving access to data and services.

Technology

The technology component is in all three monitoring system measured by the availability of services to download and view data. IDEC also measures the availability of other geoservices and the usability of services. However it could not be identified from the available material how usability is measured. To calculate indicators GIDEON and INSPIRE use lists of data sets and services defined in the legal framework or policy documents as being part of the SDI. The indicator values are derived from those lists by calculating the % that is available at the time of measurement.

Table 3 Indicators used in the monitoring systems of GIDEON, INSPIRE and IDEC grouped by SDI component

Component	GIDEON	INSPIRE	IDEC
People	Visitors georegister (1.1)	Use network services (7)	Nr. of metadata providers (7)
	Use view/downl. serv. (1.3)	Use of infrastructure (11)	Nr. WMS providers (8)
	Turnover GI business (€) (2.3)	Stakeholder involvement (10)	Nr. of visitors portal (10)
	Level of cooperation (3.1)		Nr. Participants in theme (9)
	Use in E-government (3.2)		Nr. visitors viewer LOCAL (11)
	Nr. Of GI events (4.1)		Users + downloads MetaD (13)
	Nr. of vacancies (4.2)		Use of applications (14)
	Value of GI sector (€) (4.4)		Use of applications third parties (15)
			Departm. with metadata (4)
			Departments giving access to WMS (17)
			Municip. with metadata (18)
			Municipalities giving access to WMS (19)
Technology	Availability of services (%) (1.2)	Discovery service metadata (%) (5)	Nr. of WMS (2)
		Data download services (%) (6)	Nr. WFS (3)
			Nr. of geoservices (4)
			Usability of services
Policy	Policy terms for (re)use GI (2.1)	Data sharing arrangements (12)	Activities on harmonization of data policy (20)
	% datasets without restriction (2.2)	Coordination and quality assurance (9)	Diffusion and education activities (22)
	Private sector expenditure R&D (4.3)	Cost benefit aspects (13)	
Standards		Conformity metadata (%) (2)	
		Conformity data sets (%) (4)	
		Conformity of services (%) (8)	
Data	Availability of datasets	Existence of metadata	Activities data harmonization
		Geographical coverage (%)	Nr. of metadata records
			Nr. of maps accessible

Policy

All three monitoring systems monitor issue related to data policy and availability of data for other parties. Most of those indicators have a rather descriptive character. INSPIRE monitors policies for coordination and quality assurance. IDEC is monitoring diffusion and education activities. INSPIRE requires also analysis of cost-benefit aspects of the SDI infrastructure. Further, funding and budgetary issues like yearly expanses on SDI implementation, are not measured by the SDI monitoring systems.

Standards

INSPIRE monitors the conformity with standards using indicators for metadata, data and services. The monitoring systems of GIDEON and IDEC have no specific indicators for standards. A possible explanation is that the use of standards is not an explicit goal, but a mean for use and application of data and services.

Data

The three monitoring systems monitor the data component by the availability of data sets (GIDEON), existence of metadata (INSPIRE), and number of metadata records and accessible maps (IDEC). Values are derived as a % of a lists of data and services to be included in GIDEON, INSPIRE and IDEC.

3.3 ANALYSIS OF ORGANIZATIONAL ISSUES

Table 4 describes some key organizational characteristics of the three monitoring systems. The characteristics are grouped by coordination and organization issues, stakeholder participation and the operationally of SDI monitoring systems. Those issues are further analysed and discussed.

Table 4. Organizational characteristics of the GIDEON, INSPIRE and IDEC monitoring systems

Organization issues	GIDEON	INSPIRE	IDEC
Coordination/organisation	Based on policy framework	Based on legal framework	Based on legal framework
	Reporting to GI council	Reporting to European Commission	Reporting to coordination body
	Coordinated by Ministry	Coordinated by authorities in member states	Coordinated by SDI support centre
Participation	Stakeholders involved in setting up monitoring system	Stakeholders involved in setting up monitoring system	Unknown
Operationally	Data from portal and additional studies	Data collected by member states	Data from portal and additional sources
	Operational since 2009	Operational since 2010	Operational since 2006
	Reported on once a year	Reported on once a year	Reported on once a year

Coordination/organisation

The three monitoring systems are all based on a policy or legal framework. The INSPIRE directive and the Catalan Geographic Information law explicitly require the need for monitoring and yearly reporting to respectively the European Commission and Catalan coordination body. GIDEON monitoring is based on the policy document for the national SDI policy, where the need for monitoring to the GI council is stated. For further information on the coordination and organisation see also the case study description (section 3.1).

Participation

In GIDEON the SDI stakeholders have been directly involved in selecting the indicators for the monitoring system. Data is collected by the SDI coordination body Geonovum and is based on statistics from the national georegister and additional sources. The INSPIRE monitoring system has been designed by a drafting team of experts. Stakeholders had the possibility to comment on drafts in several consultation rounds. Data collection is the responsibility of the Member states authorities and is designed to be simple and automated (using tooling) as much as possible. The design for the IDEC monitoring has mainly been done by the IDEC support centre. No information could be found about how stakeholders have been involved. Data for IDEC is mainly based on statistics of IDEC websites and information provided by stakeholders.

Operationally

All three systems are operational and the results are yearly reported. GIDEON indicators have been measured once, but have been used more like a proof of concept then as implementation instrument. The INSPIRE monitoring system should be operational since June 2009. However, results of the INSPIRE monitoring are not available yet. Many member states are working still on setting up the INSPIRE monitoring systems. The IDEC system has been applied for 2006, 2007 and 2008 and based on measurements and target values indicator values and a general index for IDEC has been calculated and can be considered as fully operational. However, no information could be found how the results have been used in the implementation process of IDEC.

4. CONCLUSIONS AND DISCUSSION

The operationally of the monitoring system show that SDI monitoring can be done on basis of indicators measuring different aspect of SDI development. Similarities and differences can be identified between the different monitoring systems. Based on our analysis of the three monitoring systems, an evaluation of the GIDEON monitoring system described in [9] a discussion on the INSPIRE monitoring system described in [22] common issues to be taken into account monitoring SDIs can be identified.

Based on the analysis and grouping per component of the indicators of the three monitoring systems general characteristics can be described and discussed. For monitoring of the user base all monitoring systems use indicators showing a trend. Indicators measure the number of users of the portal and indicators for the use of view- and download services. A growing value of an indicator over a period of time can be considered as a good result. The measurement of this type of indicators can be kept simple and be automated using statistical tools. Many of the indicators to measure the technology, data and standards component can also be measured automated. They are based on lists of data sets and services defined in the legal framework or policy documents. The indicator values are derived from those lists by calculating the % that is available or in conformity the standard at the time of measurement. This enables showing trends and progress and allows assigning responsibilities. However, this requires the availability of a list of data sets and services that should be considered part of the SDI infrastructure. Defining those lists and assigning responsibilities can be a difficult process [22].

Other indicators for the use and policy component can be described as more soft indicators. Indicators that focus on the involvement of stakeholders, cooperation, data sharing arrangements, policy terms for reuse and level of activity are more are more difficult to define, measure and implement. Vandenbroucke et al. [22] in their discussion of the INSPIRE monitoring systems argue that this type of indicators might be more easily provided through the reporting mechanisms then by indicators. Organizational and policy structures are not things to be 'calculated' and are not expected to change significantly over time. For INSPIRE monitoring this was limited to a chapter on sharing in the three-yearly reporting of INSPIRE. Also GIDEON and IDEC formulated indicators for policy issues that seem to fit better with a more descriptive approach then real measurement of progress in time. GIDEON and INSPIRE also formulated economic indicators to measure the use and impact of the infrastructure. This can give more quantitative insights in expenses and benefits of the infrastructure, but specific measurement of SDI costs, benefits and economic impacts is difficult (see e.g. [24],[25]).

From the organisational perspective the monitoring mechanism should be kept simple and be automated as much as possible and cause not too much burden when applied. Therefore every indicator should be carefully evaluated if it really needed and is adding value to the SDI monitoring system [22]. Portals can be a good source to collect statistical data of availability of data and services and the use. Organisational indicators are more difficult to implement and interpret and information might be more easily provided through reporting mechanism. Furthermore, to assure the quality and effectiveness of the monitoring stakeholder involvement in design, reviewing, testing and constant evaluating of the monitoring system is important.

The objective of this paper was to describe, analyze and compare comprehensively the design and application of three operational SDI monitoring systems and identify common issues to be taken into account monitoring SDIs. Important lessons can be learned from operational SDI monitoring systems. This can support further improvement evaluation practices and operational setups of SDI monitoring systems. However, each SDI requires a specific monitoring systems and indicators suited for a specific assessment view and purpose. Therefore no ´ready to use´ assessment approach can be provided. Furthermore, it requires further study to analyze how the results of SDI monitoring can be used and in the design and implementation of SDI practices.

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ANNEX

GIDEON goals and indicators (source [9]):

Goal 1: the public and businesses will be able to retrieve and use all relevant geo-information about any location

Indicator 1.1 The number of visitors of the Dutch National GeoRegister (NGR)
Indicator 1.2 Availability of datasets and services (indicator source: NGR)
Indicator 1.3 The use of view and download services (Source: TNO, DINO)

Goal 2: businesses will be able to add economic value to all relevant government-provided geo-information

Indicator 2.1 General governmental policy terms for (re)use of geographical information.
Indicator 2.2 The percentage of datasets from GIDEON Annex 1 that are available without any restrictions (indicator source: NGR).
Indicator 2.3 Yearly turnover of the geo-information business in the Netherlands (Indicator source: Geobusiness Nederland).

Goal 3: the government will use the information available for each location in its work processes and services.
Indicator 3.1 The level of cooperation within 5 chains of GIDEON (source [21]
Indicator 3.2 The use of geo-information within e-government processes (Indicator source: http://monitor.overheid.nl).

Goal 4: the government, businesses, universities and knowledge institutes will collaborate closely on the continuing development and enhancement of the key facility.

Indicator 4.1 The number of Geo-information events (Indicators source: www.geo-info.nl).
Indicator 4.2 The percentage of organizations with unfulfilled vacancies in the geo-sector (Indicator source: Geobusiness Nederland).
Indicator 4.3 Expenditure of the private sector in the Netherlands on research and development of geo-information products and services (Indicator source: Geobusiness Nederland)
Indicator 4.4 Value of the Dutch geo-information research sector. (Indicator source: Geobusiness Nederland).

Indicators for the INSPIRE monitoring
(source [15])

8 indicators to be continuesily monitored:

1. Existince of Metadata (%)
2. Conformity of Metadata (%)
3. Geographical coverage of spatial data sets (%)
4. Conformity of spatial data sets (%)
5. Accessibility of metadata through discovery services (%)
6. Accessibility of spatial data sets through view and download services (%)
7. The use of network services
8. The conformity of network services (%)

Each member state needs to report 3 yearly about use and implementation of the spatial data infrastructure, describing the 5 following items:

9. Coordination and quality assurance.
10. Contribution to the functioning and coordination of the infrastructure (stakeholders involvement).
11. Use of the infrastructure for spatial information incl. use cases.
12. Data sharing arrangements.
13. Cost and benefit aspects.

Indicators for the monitoring of IDEC (Catalonia)

(source [16])

1.- Available resources

1. Number of metadata records in Catalogue (in Catalan)
2. Number of accessible WMS (according to catalogue)
3. Number of accessible WFS (according to catalogue)
4. Number of geoservice offered
5. Number of maps accesible

6. Usability of services (perception): estimating attractiveness, ease of use and speed of services

2.- Participation

7. Number (entities) of metdatadata providers (according to catalogue)
8. Number (entities) of WMS providers (according to catalogue)
9. Number (entities) of participants in IDE´s theme´s (local, university, costas)

3.- Use

10. Monthly number of visitors IDEC: portal + viewer + catalogue
11. Monthly number of visitors of viewer LOCAL: roadmap + maps + internal + urban
12. Total number of entities registered for geoservices
13. Number of users and downloads of MetaD
14. Number of participating entities using IDEC applications as source
15. Number of entities, third parties, using IDEC applications.

4.- Degree of fulfillment with the law

16. Number of departments with Metadata published
17. Number of departments facilitating access to WMS
18. Number of municipalities with metadata published
19. Number of municipalities facilitating WMS access.

5.- Other aspects

20. Estimation of activities on Harmonization of data policy
21. Estimation of activities on harmonization of data
22. Activities on education and diffusion