ABSTRACT

This paper provides results from a worldwide impact assessment of spatial data clearinghouses. Its aim is to assist policy makers in their task of evaluating whether or not investment, in setting-up and maintaining these establishments, is justified. In order to achieve this objective a procedure was devised for the comprehensive and systematic evaluation of sustainable development within the worldwide clearinghouse population. The assessment procedure entailed a survey undertaken by clearinghouse coordinators. A range of economic, social, and environmental indicators was chosen to evaluate the relevance, efficiency, and effectiveness of clearinghouses. This paper also presents the results of complementary analyses, which were carried out to assess the significance of the impacts recorded. They were also used to assess the objectivity of the responses of the coordinators. The results of these assessments reveal that clearinghouses have mainly positive impacts. In addition, the results also indicate the significance of clearinghouses as relevant facilities for enhancing spatial data accessibility, providing efficient means of accessing spatial data, and the effective promotion of data use and distribution. Finally, it is argued that the results obtained could be used to justify present and support future investments in the clearinghouse system.
1 INTRODUCTION

Many international regions, countries, states and counties throughout the world have spent considerable resources over the past few years implementing and managing Spatial Data Clearinghouses (SDCs). These SDCs can be considered to be a prominent feature of Spatial Data Infrastructures (SDI) (Clinton 1994, Federal Geographic Data Committee 1997, Onsrud 1998, Crompvoets, et al. 2004), because they are the facilities for making spatial data accessible to the general public, and promoting data sharing. SDCs facilitate the searching, viewing, transferring, ordering, publishing and/or disseminating of spatial data and services from numerous sources via a web site (interface) on the Internet, and as appropriate, providing complementary services. Such SDCs contain data catalogues, which are access systems that use metadata (INSPIRE Architecture and Standards working group 2002, Maguire and Longley 2005, Tait 2005).

The access service for spatial data on the web is known variously within the spatial community as clearinghouse, catalogue services, spatial data directory, geoportal and geospatial one-stop portal. Although different names are used it is obvious that the goals of accessing spatial data through the metadata remain the same (Crompvoets, et al. 2004, Beaumont, et al. 2005). The enhancement of data/service accessibility, and the sharing of spatial data and related services between suppliers and users are considered to be the main reasons to build these electronic facilities (Bernard, et al. 2005, Beaumont, et al. 2005, Maguire and Longley 2005).

Based on an overall assessment, the average cost of a SDC is around € 1,500,000 a year (Southern California Association of Governments 1998, INSPiRE Architecture and Standards working group 2002, Pasca, et al. 2004). This money is spent on management and coordination costs, GIS and Internet application development, training, hardware, standardization activities, legal environment creation, and metadata preparation. Currently, around 500 (non-corporate) SDCs have been established and it is expected that many more SDCs will be set up in the future. This indicates that on a global scale hundreds of millions are spent yearly on SDC activities. Up to now this large investment has rarely been audited or evaluated. A study conducted by the Urban and Regional Information Systems Association (Gillespie 2000) cited that while the costs of SDC projects may be relatively easy to assess and highly ‘front-loaded’, the benefits are often very difficult to measure and may not emerge until well into the life of the SDC and depend on other factors coming into play (Federal Geographic Data Committee 2002, Commission of the European Communities 2004).

SDCs could be developed at different administrative levels ranging from local to state/provincial, national, and international levels, to a global level, to better access and share spatial data and related services. There is a need to address politicians and decision-makers to demonstrate the benefits of such a system. One of the difficulties in selling the benefits to decision-makers has been the paucity of systematic evidence of the full economic, social and environmental impacts. This was highlighted in the context of Geospatial One-Stop (Federal Geographic Data Committee 2002), and the Extended Impact Assessment of the INSPIRE-initiative (Commission of the European Commission 2004). However, it has been difficult to extrapolate impacts from these individual cases to reach more generalized conclusions. In addition, it is critical to
move away from a narrow focus on the technical considerations of SDCs to their potential contribution to area competitiveness, innovation, productivity, job creation, etc. (Craglia, et al. 2003).

The focus of this paper is on the worldwide impact assessment of the current SDCs with the main objective of providing this information to policy makers, in order to assist them in their task of evaluating whether or not investment in setting up and maintaining these SDCs is justified. In this context, the term ‘impact’ is described as the (positive or negative) effect that SDCs could have on society. Few studies exist about the worldwide impact of these facilities. To the best of the authors’ knowledge, no comprehensive and systematic impact assessment has taken place. The purpose of the present paper is to fill this gap.

This paper presents and assesses the impacts of current SDCs throughout the world with reference to the economic, social, and environmental dimensions. The impact assessment presented here is based on a survey undertaken among coordinators of known SDCs of the world using indicators to assess the relevance, efficiency and effectiveness. Complementary analyses are implemented in order to interpret the significance of the impacts.

1.1 Introduction to Impact Assessment

Impact assessment is a key tool for improving policy-making and implementation, and promoting sustainable development (Long and Alastair 1997, Commission of the European Communities 2002, Bråthen 2003). Many techniques can be used to assess the impacts (Jorgenson 1998, Environmental Protection Agency 2000), but whatever method is used the results need to be transparent, reproducible and robust. To make comparison accurate as possible, it is recommended that impacts are expressed in quantitative and monetary terms (e.g. cost – benefit analysis) in addition to a qualitative appraisal.

Impact assessment identifies and assesses problems arising from the pursued of the objectives, and the available options to achieve those objectives. It also highlights the positive and negative impacts with their respective advantages and disadvantages, including synergies and trade-offs (Commission of the European Communities 2002, Bråthen 2003). Any assessment should be based on the following criteria:

- Relevance for solving the problem.
- Efficiency in the use of human and financial resources.
- Effectiveness in achieving the defined objectives.

These assessments of impact are difficult mainly because of the degree of uncertainty in the reliability of the data, the assessments of the proportion of the impacts, the range of affected stakeholders, the short and long-term developments, and the efficacy of the assessment method.

Systematic assessment of impacts should also consider sustainable development. Sustainable development is based on the idea that in the longer run economic growth, social inclusion and environmental protection should go hand in hand. At this moment, many governments regard these economic, social and environmental dimensions as the main driving force behind their policies (Williamson, et al. 2003).
The economic, social and environmental impacts should be identified and cover all positive and negative effects, including costs and benefits. Economic, social and environmental impacts have been identified by the report of the European Communities (2002).

1.2 Existing Impact Assessment Studies


Previous assessment research focused mainly on the impact of one SDC and was neither comprehensive nor systematic (Price Waterhouse Nederland 1996, Federal Geographic Data Committee 2002, Commission of the European Communities 2004, Pasca, et al. 2004, Tait 2005, Walther 2005). As with many SDI-initiatives, the majority of impacts were qualitative in terms. The main findings of these six studies are that SDCs:

- Improve the availability, accessibility, usability and ‘downloadability’ of data supplied.
- Are cost effective and efficient. For example, the Benefit Cost ratio, related only to the reduction of time to access data, ranges from 1.1 to 4.
- Widen the range of users with different levels of education and technical skills.
- Increase the awareness of spatial data amongst the general public.
- Enhance the performance and productivity of (publicly funded) organizations.
- Improve metadata quality.
- Increase government participation.
- Support better decision making.
- Are catalytic to innovation and new ways of working.
- Improve partnerships.

These initial assessment results and literature (e.g. Groot and Sharifi 1994, Askew, et al. 2005, Maguire and Longley 2005, Beaumont, et al. 2005), suggest that SDCs are a relevant means to enhance data accessibility as well as data sharing, effective and efficient in the use of human and financial resources.

In contrast with the previous assessment research, this paper is focussing on the worldwide clearinghouse population and is comprehensive and systematic.
2 METHODOLOGY

This paper focuses on the development and implementation of a procedure to assess the impacts of currently existing international, national, federal, interstate, state, county and local SDCs of the world. The ‘pre-clearinghouse situation’ was considered to be the baseline against which to assess the current impact of SDC-development. The ‘pre-clearinghouse situation’ refers to when no electronic facility existed on the Internet to access spatial data using metadata. To undertake the assessment it was important to take into account developments over time, to use existing knowledge and experience, to consult interested parties and relevant experts, to be transparent, and to compare negative with positive impacts.

Assessment difficulties have circumscribed the very few studies containing quantitative and qualitative information on the impacts of SDCs. Therefore, the approach chosen in the study was to determine impacts by referring to the expert knowledge and experiences of SDC coordinators as their perceptions are sensitive indicators for changes as well as impacts. These coordinators organize activities as management, marketing, technical and legal environment creation, and human resources so that their SDCs operate well. Other reasons to focus on SDC coordinators were their intermediate role between data/service suppliers and users, their awareness of the historical, institutional, cultural, legal, economic and technological context, and their ability to provide accurate data about the development, use, management, content and technology of their SDC. Moreover, they were relatively easy to contact. This was not the case with the data users as well as suppliers of SDCs. In addition, the expertise and experiences of a selected number of European SDC practitioners (users and data/service suppliers) were used to evaluate the objectivity of coordinators’ perceptions. The availability of this expertise meant that the impact in terms of economic, social and environmental context could be described fairly comprehensively.

The procedure used in this assessment study consisted of the following steps:

- Undertaking extensive literature research (see section 1.2 existing impact assessment studies).
- Determining assessment indicators in order to evaluate the relevance, efficiency and effectiveness.
- Designing and conducting survey in order to collect information about the perceptions of coordinators.
- Analyzing results by categorization of the SDCs in order to facilitate the interpretation of these results.
- Assessing the objectivity of coordinators’ responses.

2.1 Determining Assessment Indicators

The assessment was confined to the use of number of economic, social and environmental impact assessment indicators, because a full implementation of a quantitative assessment study was proscribed by cost considerations. These indicators were measurable and illustrative (Taylor, et al. 1990). They could measure the relevance, efficiency and effectiveness of SDCs and provide insight into how economic and social structure and environment alter when SDCs are implemented.
The selection of indicators was based on expert knowledge, literature and direct relevance for SDCs.

The economic indicators used were:
  • Consumption of data/services.
  • Data market transparency.
  • Duplication of data collection.

The social indicators were:
  • Spatial data/service awareness.
  • Social cohesion between citizens.

The only environmental indicator was:
  • Data delivery for environmental policy formulation.

2.2 Designing and Conducting Survey

The survey was undertaken (November 2004 – April 2005) to collect information about the perceptions of coordinators. A questionnaire was distributed to all known coordinators of SDCs. This survey was strongly supported by the INSPIRE expert group (a group composed of representatives of the European Commission, and member states’ Environmental and GI-communities) and the Executive Board of the Permanent Committee of GIS Infrastructure for Asia and Pacific (PCGIAP).

It was important that as many SDC coordinators as possible completed the survey to provide a full and reliable impact assessment. For this reason an inventory of identified SDCs was compiled by extensive browsing on the Internet (using several search engines), reading literature, contacting experts and SDC coordinators. Where possible the e-mail address (and name) of the SDC coordinator was collected.

A questionnaire was used to collect the relevant information. The questions were based on current literature as well as expert knowledge, so that the coordinators’ perceptions of their SDC could be analyzed. Most questions could be answered by selecting the appropriate option boxes; none of the questions were ‘open’. The questions were framed in a way that they described the impacts of SDCs as well as the future developments. The questions were:

1) On which administrative level listed is your SDC mainly operating? (In section 2.3 the administrative levels listed are presented).
2) Which of the countries listed does your SDC cover (partly) metadata? (193 countries were listed).
3) Which of the options listed are the main benefits of your SDC? (Figure 3 presents the benefits listed).
4) Which of the options listed are the main drawbacks of your SDC? (Figure 4 presents the drawbacks listed).
5) Which of the options listed is likely to take place with your SDC within the next five years? (In section 3.3 the future options are partially presented).

Moreover, fourteen statements were formulated to assess what SDC coordinators considered to be the impacts of their SDC on a scale from strongly agree to strongly disagree. Examples of such statements were:

a) Your SDC increases the consumption of spatial data and services.
b) Your SDC improves data market transparency.
c) Your SDC reduces data duplication.
d) Your SDC improves the awareness of spatial data.
e) Your SDC strengthens the social cohesion between citizens. This statement refers to the solidarity and social bonding between people within state, country or international region.
f) Your SDC improves the appropriate data delivery for environmental policy formulation.
g) Establishment and maintenance of your SDC is economically beneficial.

In addition, there were supplementary statements designed to check the face validity of the responses.

The questionnaire was distributed using e-mail and was addressed personally to the coordinators. The main advantages of the use of e-mail are that it is fast, easy and cheap for distribution. In total, 428 coordinators were contacted.

2.3 Analyzing results

The analyses were carried out to process the answers and to interpret the results better. The worldwide answers were aggregated. However, as the world is very diverse in historical, institutional, legal, cultural, technological and economic respects, and different Geographical Information (GI) processes take place at different administrative level, the variability of the answers between regions and administrative levels were categorically analyzed. The classification by region was based on the division of Dorling Kindersley (2002). Eight administrative levels were identified: 1) worldwide, 2) continental, 3) international, 4) national (federal), 5) interstate, 6) state, 7) county and 8) local. The Chi square and Fisher exact tests (Agresti 1990) were used to test whether respondents at different regional areas and administrative levels reacted differently to the questions and statements of the questionnaire. Throughout, test results with a (1-sided) p-value of less than 0.1 were considered significant.

2.4 Assessing the Objectivity of Coordinators’ Responses

As the results of the questionnaire were all based on the response from the SDC coordinators it was expected that their views could be biased. To mitigate this, a comparison of responses from the European SDC coordinators with those of the European user community was made, assuming that the objectivity of European coordinators’ responses represent well the objectivity of all SDC coordinators’ responses. To facilitate this procedure a short version of the questionnaire was distributed to 75 European representatives of the GI-user community (June - August 2005). These practitioners were member of the INSPIRE Expert Group, and were considered to be important stakeholders who could use SDCs to access or supply spatial data (e.g. ministries, municipalities, mapping agencies, cadastres, universities, public/private institutions, utilities, etc.). The Chi square and Fisher exact tests were also used to test the differences of the views between the European SDC coordinators and these practitioners.
3 RESULTS AND DISCUSSION

The inventory resulted in a list of 456 SDCs (of 80 countries) of which 428 had personal e-mail addresses of their SDC coordinator. Figure 1 indicates the worldwide distribution of all identified SDCs by country. It appears that the establishment of SDCs has become a global activity as recorded by Crompvoets and Bregt (2003), and Crompvoets et al. (2004). Most SDCs are established in Europe, Southeast Asia, North and South-America. The countries with the highest number of SDCs are USA and Canada. The areas with few implementations are Africa and The Middle East.

A total of 105 coordinators from 31 countries completed the survey; 25% of the population of coordinators. This percentage is in line with the responses to similar types of surveys (Hamilton 2003). This sample size was adequate in respect to the SDC population in the developed world since the respondents were mainly coordinating SDCs in North America (USA/Canada) (41%), Europe (32%) and Australia (8%) (only 19% in total were African, South American and Asian ones (Figure 2)). In order to obtain reliable results, the regional analysis included only the North American, European and Australian ones. The other regions were excluded from the regional analysis due to limited number of responses.

As mentioned earlier, the survey identified eight administrative levels (question 1). To achieve reliable statistical analysis, several levels were reclassified. Finally, three classes were considered: 1) (inter)state, 2) national (including federal), and 3) international. Classes interstate and state were reclassified into (inter)state (41%); class national was unchanged (31%); classes worldwide, continental, and international were reclassified into international (20%); classes county and local were excluded from the administrative level analysis (8%).

![Figure 1 Worldwide distribution of spatial data clearinghouses (456) by country.](image-url)
Figure 2 Worldwide distribution of survey responses (105) by country.

3.1 Benefits and Drawbacks

The enhanced access to spatial data, and the improved data sharing and distribution are regarded as the main benefits (question 3) of the current SDCs (Figure 3). This confirms the results derived from the previous studies and literature (section 1.2). On the basis of this result, it seems that overall SDCs are relevant facilities to access data/services and to promote sharing. However, many SDCs still lack integration among suppliers and users. This could result in inefficient use of resources, potential duplication, inconsistency, incompatibility, and the inability to maximize the value of data and services. The main benefits appear to be mainly economic in nature. Minor benefits are the more effective use of available data, the improved spatial data awareness and the reduction of spatial data duplication. Cost savings are not really seen as a benefit, which could be an indication that SDC coordinators are not very cost conscious.

Coordinators of North-American SDCs regard the reduction of data duplication, the improved data sharing and distribution significantly more as benefits (this is in contrast with European SDCs).

In addition, coordinators of international SDCs see the reduction of data duplication significantly less as a benefit. This is in contrast with (inter)state coordinators who also look upon cost savings significantly more as a benefit.
Figure 3 Worldwide distribution of SDC coordinators’ responses (%) relating benefits of spatial data clearinghouses.

It appears that besides costs and funding (80%) not one single drawback (question 4) could be identified as another important obstacle for SDC implementations and maintenance (Figure 4). Institutional problems (33%), lack of specialized data managers (25%), and data standardization (23%) can however be considered as significant drawbacks. The lack of harmonized reference systems (3%), and liability problems (12%) and inadequate Internet bandwidth (16%) are less significant as drawbacks for SDC implementation. This result is in line with literature (INSPIRE Architecture and Standards working group 2002, Federal Geographic Data Committee 2002, Wehn de Montalvo 2004, Askew, et al. 2005). None of the main obstacles are (directly) technology-related. It seems that the challenges to be faced are more likely to be organizational than technical.

North-American coordinators consider lack of specialized managers significantly more as a drawback and problems with data pricing less. On the other hand, the European SDC-coordinators look upon problems with data pricing and commercialization of data significantly more as a drawback.

The high degree of correspondence in coordinators’ views with respect to the perceived benefits and drawbacks is significant in so far it gives a clear indication that SDCs worldwide function within a broadly similar operating environment.
3.2 (Economic, Social and Environmental) impacts

Economic Impact. The economic impact is primarily assessed by the use of economic indicators. Several statements in the questionnaire refer to these economic indicators. The survey results show the likelihood of higher consumption of spatial data and services, as well as the reduction of data duplication as the main economic impacts. This impact result is illustrated in Figure 5, which presents the responses of SDC coordinators to three economic indicators: consumption of data and services (statement a), data market transparency (statement b), and duplication of data collection (statement c). On the basis of these results, it is apparent that the vast majority of respondents agree with the statement that their SDC increases the consumption of spatial data and services. This implies that this increase of consumption could be regarded as the most important economic impact. Additionally, a majority also agrees with the statement that their SDC reduces duplication of spatial data. The result related to the statement that SDC improves data market transparency is not clear (the majority neither agrees nor disagrees). On the basis of the responses related to these three economic indicators it could be deduced that SDCs have a significant (positive) impact on the economic dimension.
Looking from regional perspective, evidence can be found that more North-American coordinators agree with the statements that their SDC increases the consumption of spatial data and services, and reduces duplication of spatial data.

Evidence exists that national SDCs agree less that their SDC increases the consumption of spatial data and services while (inter)state SDCs agree more that their SDC reduces duplication of data.

![Figure 5](image)

**Figure 5** Worldwide distribution of SDC coordinators’ responses (%) to statements relating economic indicators.

Besides the statements directly related to the indicators the coordinators could also respond to the statement that establishment and maintenance of their SDC is economically beneficial (statement g). 70% of the coordinators agree and only 11% disagree with this statement. Since the main benefits and drawbacks are likely to be economic in nature, this result indicates that SDC coordinators perceive that the positive impacts more than counterbalance the negative impacts.

Both data users and suppliers could gain economically by the implementation of SDCs. Data users benefit from the improved efficiency to access spatial data, and data suppliers from the increased effectiveness to distribute their spatial data and the improved efficiency to collect data by reducing data duplication. It seems that the establishment and maintenance costs of these facilities are economically justified, although the cost savings for the SDC coordination organizations appear a less important impact.

**Social Impact.** The social impact is primarily assessed by the use of social indicators. Two statements in the questionnaire refer to these indicators: spatial data/service awareness (statement d), and social cohesion between citizens (statement e). These
impact results are illustrated in Figure 6. From the responses of SDC’s coordinators, it is apparent that the vast majority agrees that their SDC improves spatial data awareness. This implies that this improvement of spatial data awareness could be regarded as the most important social impact. It appears that SDCs could change the way society is using this spatial data. In many decision-making processes the role of spatial data is increasing. SDCs improve (indirectly) these processes in a way that enable stakeholders to become better informed. Additionally, a majority also agrees that their SDC strengthens the social cohesion. It appears that SDCs are, for example, able to provide equal spatial information access to rural, urban and remote communities, which will support local decision making capacity development and new socio-economic activities in these communities. In view of these social results it is reasonable to deduce that SDCs have a significant impact on the social dimension.

From regional perspective, evidence exists that North-American coordinators agree more with the statement that their SDC improves the awareness of spatial data. From administrative level perspective, no differences in agreement exist.

![Figure 6](image)

**Figure 6** Worldwide distribution of SDC coordinators’ responses (%) to statements relating social indicators.

**Environmental Impact.** The environmental impact is assessed by the use of one environmental indicator: data delivery for environmental policy formulation (statement f). The coordinators expect little impact on the environment. From the response it appears that the majority of the coordinators neither agrees nor disagree (60%) with statement f. SDCs do not seem to deliver the data appropriately for environmental policy formulation. Nevertheless, some environmental policy-makers make use of SDCs to access the needed spatial data and services (Williamson 2004).

From regional perspective, the evidence indicates that North-American coordinators do not consider that this impact is important. From administrative level perspective, no differences in agreement exist.
Examining assessment indicators in combination with the benefits, it appears that the main positive impact of implementing SDCs is economic. The high degree of correspondence in coordinators’ views with respect to the economic, social and environmental impacts is significant confirming that SDCs worldwide function within a broadly similar operating environment.

3.3 Future Developments

The coordinators were asked to select what they expect will happen with their SDC in the next five years (Question 5). A subset of their response was that:

- The use of spatial data will increase (89%).
- More (new) services will be provided (55%).
- The data quality will improve (50%).
- The use by governments will increase (49%).
- More datasets will be provided (35%).
- More specific datasets will be needed (34%).
- The metadata standards applied will be changed (31%).
- New expertise will be needed (26%).

The coordinators expect mainly that the spatial data consumption as well as the range of service provision of their SDC will increase. These developments are in line with literature (Maguire and Longley 2005, Beaumont, et al. 2005), and link strongly to the gradual shift in focus of SDC development: from data-centric to user-centric. In the 1990s, data and technology were the main driving forces for SDCs. At the present moment, the use of data (and services) and the needs of the users are becoming the main forces for SDC development (Reeve and Petch 1999, Williamson, et al. 2003; Crompvoets, et al. 2004).

The similarity in development views of the coordinators is significant showing that the coordinators have the same future objectives probably created by such external developments as expanding technologies, market-demand, changing business models, sustainable development, e-government and participatory democracy. The few differences are that more North-American coordinators expect that more datasets will be provided, and new expertise will be needed.

3.4 Assessment of the objectivity of coordinators’ responses

A total of 41 European practitioners completed a short version of the questionnaire. The high degree of correspondence between the responses of these European practitioners and the (34) European SDC coordinators with respect to the questions and statements is significant. This result implies that the coordinators’ perceptions are not unduly biased (at least the European coordinators’ perceptions), and justifies the choice to focus on SDC coordinators as reliable sources of information to assess the impacts. Furthermore, the practitioners look upon cost savings as a more significant benefit, and consider the improved awareness of spatial data as a less important impact. This indicates that the coordinators underestimate the efficiency of SDCs and overestimate the improved awareness.
3.5 Methodology used

The implementation of the assessment procedure was appropriate to measure the impact of SDCs on a worldwide scale in order to assist policy makers to decide whether investments in the establishment and maintenance of SDCs are justified. When compared to previous studies, the strength of this impact assessment was that it was comprehensive and systematic, reproducible, robust, expert knowledge based, and that it identified significant economic and social impacts. Through the survey it was possible to gather the perceptions of the coordinators in a fast, cheap, and easy way. The complementary analyses were needed to interpret the results of the survey. The main limitation of this study was that only qualitative impacts could be assessed and it was not possible to determine quantitative measures such as financial impacts. The current experiences of the SDC operations are limited by the fact that they are still at an early stage of their development. There is a need to refine methodology so that more precise records of numerical and financial data can be recorded. In this way, a better and a more accurate grasp of financial and operational impacts could be delivered. Nevertheless, the usage of indicators gave some insight into how economic, social structure and environment alter when SDCs are implemented.

4 CONCLUSIONS

The main conclusions of this comprehensive and systematic impact assessment referring primarily to SDCs of the developed world are:
- SDCs are likely to have a positive impact on society. The main (positive) impacts are of an economic nature, but social impacts are obviously important as well. On the other hand, SDCs have likely little impact on the environment.
- SDCs could be considered as relevant facilities in order to enhance spatial data/service accessibility and to promote the sharing of these resources.
- SDCs could be considered as efficient facilities in order to enhance data/service accessibility and to reduce data duplication.
- SDCs could be considered as effective facilities in order to increase the use and distribution of spatial data/services, to improve the awareness of spatial data/services, to strengthen social cohesion between citizens, and to improve potentially better-informed decision-making.
- Costs and funding could be regarded as the main obstacle for SDC-implementation.
- In the near future, it is expected that the use of spatial data resources of SDCs will increase as well as the range of service provisions.
- Coordinators have similar views towards the benefits, drawbacks, impacts as well as future developments of SDCs. These similarities could form a perfect basis to ensure interoperability between datasets and access mechanisms, and to create a culture of sharing as well as a shared language amongst coordinators.
- North-American SDCs are considered to be the most efficient and effective facilities, and have substantial acceptance within the community. This is in line with Maguire and Longley (2005), who mention that many US as well as Canadian SDCs already in the 1990s were able to promote awareness of spatial data, create community involvement, and build capacity to access this data (Maguire and Longley 2005). The Australian SDCs form the intermediate in efficiency and effectiveness between North-American and European SDCs.
- The diversity in benefits, drawbacks, impacts, and future developments between the different administrative levels appear to be low. This could imply that the GI-
processes relating to spatial data/service accessibility do not vary much at different administrative levels.

The results obtained could be used to justify present and support future investments in SDCs. However, the authors observe that in spite of these positive results in terms of relevance, efficiency and effectiveness, the SDC concept to share resources continues to be resisted which leads to unnecessary inefficiencies resulting in duplication of data collection and storage, and consequent costs (Nedovic-Budic and Pinto 2000, Federal Geographic Data Committee 2002, Askew, et al. 2005). To utilize these SDCs effectively there must be a clear understanding of how they influence and justify their costs, and overcome institutional problems. It therefore appears that more impact assessment research is needed (e.g. case studies).

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