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Andrew J. Marr
George L. Benwell

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Local Government GIS in New Zealand Since 1989

Mr Andrew J. Marr[1]
Assoc. Prof. George L. Benwell
Computer and Information Science and
The Spatial Information Research Centre
University of Otago

September 1995

Abstract

This paper draws together existing data with recent survey results and compares the development of local government GIS with the evolution of Information Systems (IS). These comparisons are made using the philosophy that organisational GIS can be modelled. Using this model, various stages of GIS maturity are evaluated.

[1] Address correspondence to: Mr A. Marr, Department of Information Science, University of Otago, P.O. Box 56, Dunedin, New Zealand. Fax: +64 3 479 8311 Email: ajmarr@commerce.otago.ac.nz

1 Introduction

Since the mid 1980s in New Zealand the amount of spatial data being stored has steadily increased, with a conservative estimate of 800GB of stored data by 2004 [Benwell, 1995] (Figure 1).

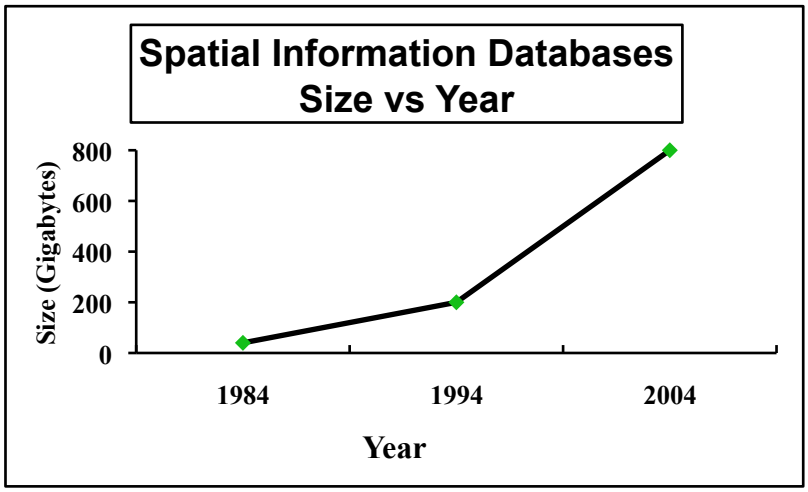

Figure 1: Analysis of Size of Spatial Data by Year in New Zealand

At the same time other methods of data collection and storage have declined (Figure 2).

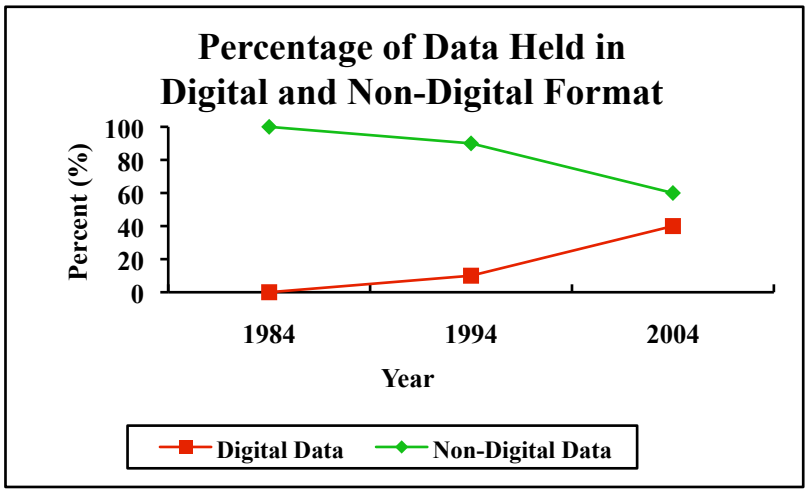

Figure 2: Analysis of Digital versus Non-Digital Data in New Zealand

In both New Zealand and Australia, central, regional, and local governments have had a key role in the collection and dissemination of spatial data.

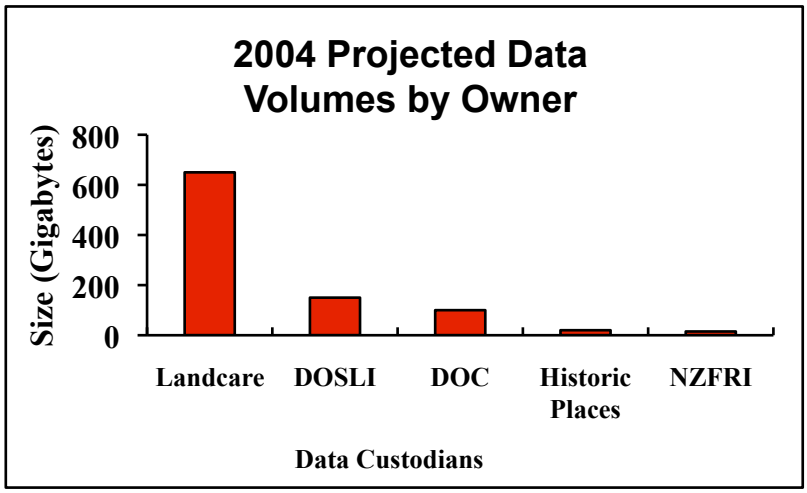

Figure 3: Analysis of Data Held by Custodians in New Zealand

Although these statistics are for New Zealand (Figure 3), there is no reason to suggest that the Australian situation would be any different. In terms of the Australian situation, given a case example [Ritman,1995], similar functions are undertaken by Landcare in New Zealand as those agencies participating in vegetation mapping in the Murray-Darling Basin in Australia. The comparative difference between Australian central government agencies and their New Zealand equivalents is related to scale [Boot, 1995]. These types of organisations tend to own large amounts of data, and most see the creation of spatial databases as a means of increasing potential efficiency in times of greater public accountability. The rest of this paper is devoted to issues relating to Local Government GIS.

Organisational maturity in terms of Information Systems (IS), as defined by [Benbasat, 1980], is based on eleven criteria including factors such as size, expenditure, management style, and the organisational location of the IS department. In the case of GIS, taken as a subset of IS, the same approach is used to assess the GIS maturity of the organisations being studied.

> *GIS maturity is defined as the degree to which systems are actually used, which in turn relates to the number of users*
>
> [Mayr, 1995 p30]

By assessing the degree to which systems are actually used (above) in advanced GIS organisations, and comparing progress with those organisations who have just received GIS technology, the maturity of organisations with GIS in between may be inferred. The proposed general stages that an organisation will go through are detailed in Figure 4.

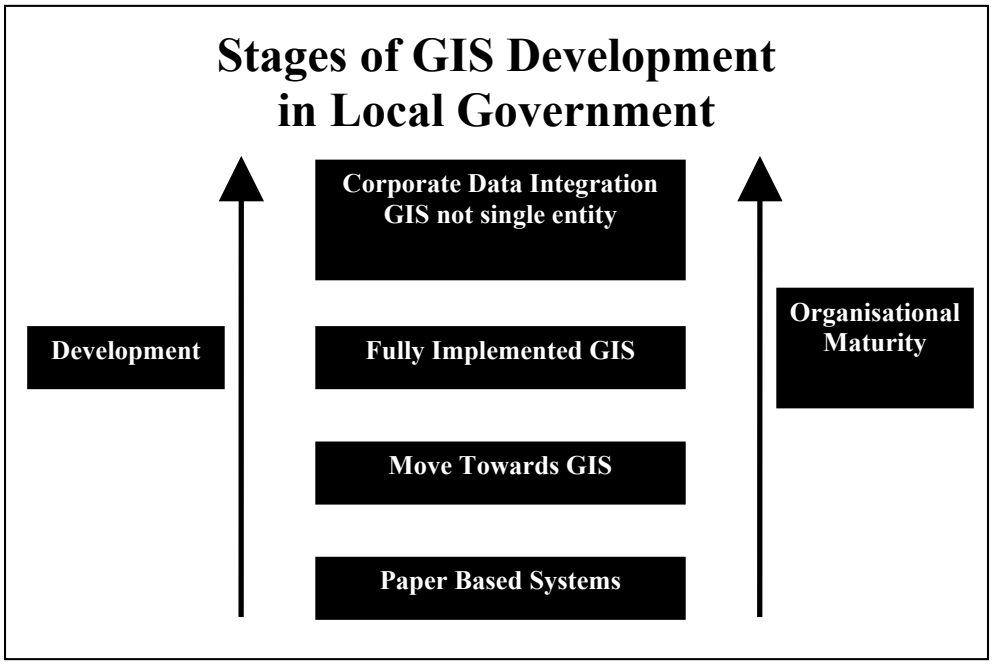

Figure 4: Stages of GIS Development in Local Government

Using the diagram above it is possible to analyse an organisation with reference to its maturity level.

2 Local Government GIS

GIS have undergone steady development in Australasian local governments [Firns, 1990]. Successive monitoring since then ([Anderson, 1992], [Anderson, 1993] and [Fraser, 1994]) has provided a useful insight into the implementation process.

In July 1995, a comprehensive study was completed by the authors which attempted to assess the present level of development, make comparisons with the previously identified studies, and draw conclusions on the general progress of GIS in New Zealand from an *overall* point of view.

Questionnaire Design

There is vast literature on the design format of questionnaires, notably, [Hoinville, 1978] , [Lockhart, 1984], [Dillman, 1978] and [Chaudhuri, 1988]. This literature details methods and procedures for obtaining high response rates and accurate respondent information. The methods adopted for the present study closely follow these recommendations.

The questionnaire form used by the authors, though originally based on one prepared by the National Center for Geographic Information and Analysis, California, USA, has remained largely intact to preserve the integrity of comparisons with the existing data. On this occasion, the survey was amended slightly to focus on the perceived future direction of the respondent in their organisational GIS development.

All 85 New Zealand local government organisations, as detailed in [Wall, 1994] were mailed the questionnaire form and cover letter in June 1995. The survey was addressed to the chief executive officer with a request to pass on the material to the person responsible for GIS in

the organisation. When the response rate reached 55%, it was decided to mail a follow up letter to non-respondents which was aimed at increasing the response rate further.

Questionnaire Results

The final response rate was 75.3% (Figure 5) which was significantly higher than in the previous studies. This represented 64 responses from 85 mailed questionnaires. Forty-five of the respondents stated that they had GIS.

The fact that the response rate was this high has the desirable effect of reducing uncertainty in the results. Response rates in the high 70% range are not uncommon for a targeted professional recipient [Lockhart, 1984]. Figure 5 shows the comparison of response rates from the past and present surveys while Figure 6 shows the increase in the number of authorities purchasing GIS over time. This has risen substantially over the last few years to the point where 70% of respondents now have GIS technology.

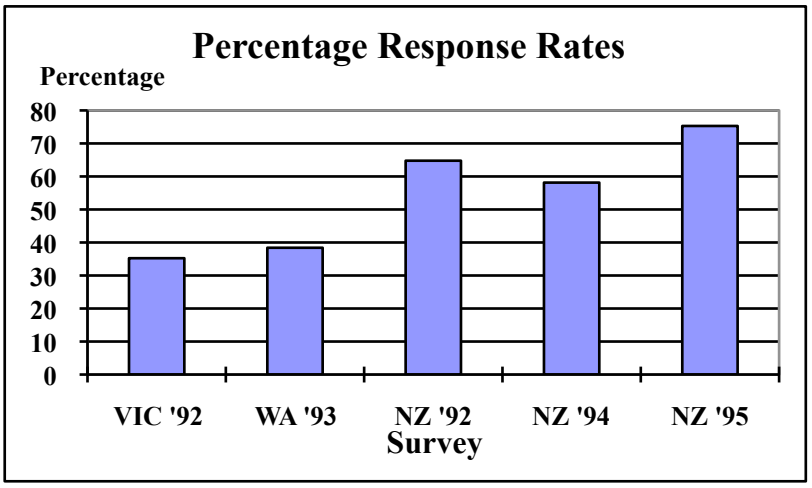

Figure 5: Analysis of Percentage Response Rate

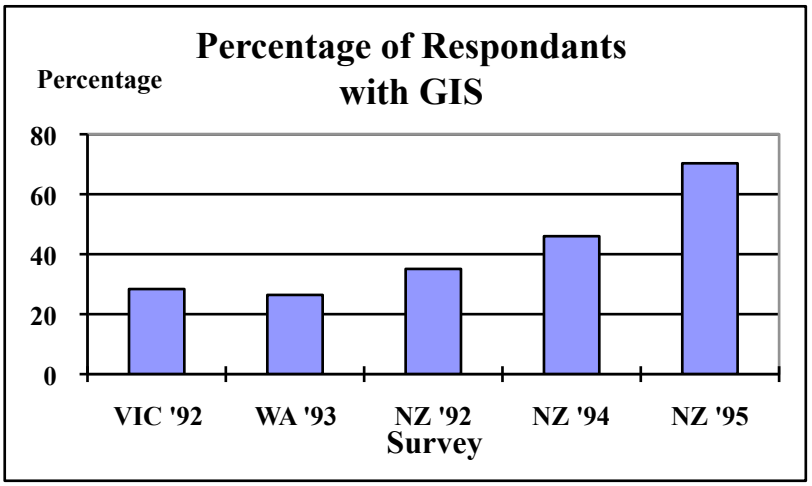

Figure 6: Analysis of Respondents with GIS

The above graph is supported by the year of GIS purchase as demonstrated by the graph below (Figure 7). A marked increase appears to have occurred in 1994 in the number of organisations purchasing GIS. The fact that so many organisations seem to have purchased GIS in this year (44% of those with GIS), will have major implications for future organisational needs and GIS development.

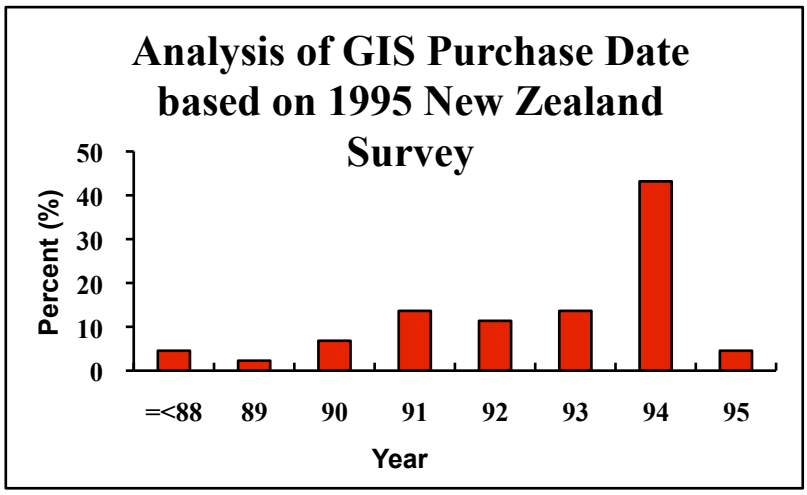

Figure 7: Analysis of GIS Purchase Date (NZ95)

The primary activities and responsibility for GIS within each organisation are shown below (Figures 8 and 9). There has been a steady growth in the primary activities of GIS being associated with '*Information Services'* (Number 7 on the graph) rather than a functional unit of the organisation eg Engineering, Administration etc.

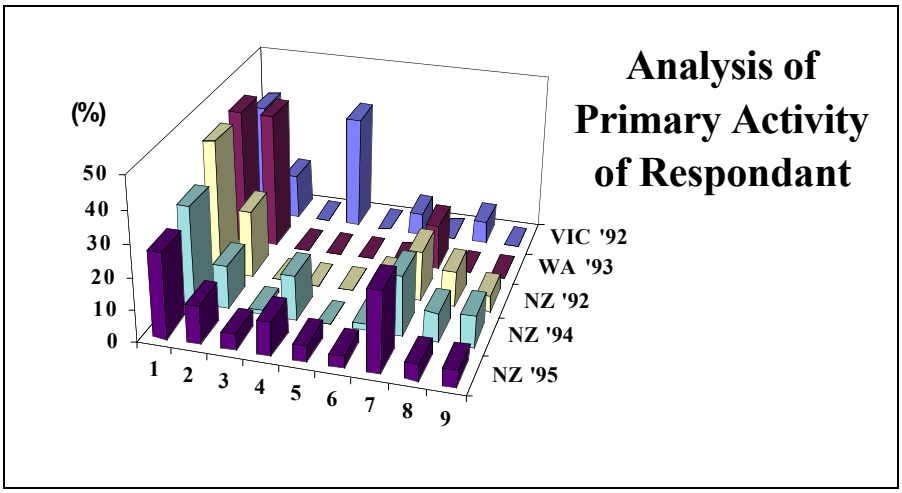

Figure 8: Analysis of Primary Activity of Respondent

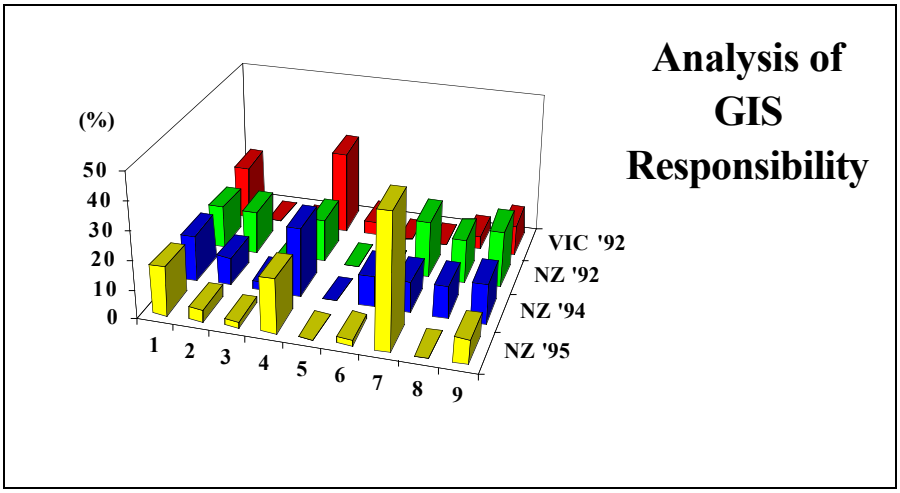

Figure 9: Analysis of GIS Responsibility

KEY
(Figures 8 and 9)

1. Administration/Management
2. Planning
3. Public Works
4. Engineering
5. Assessment Activities.
6. Regulatory Activities
7. Information Services
8. Service Provision
9. Other

Figure 11 compares how GIS is being used with the intended use at the time of purchase (Figure 10). The graphs show that GIS was bought with the intention of being used and solving a wide variety of common organisational tasks. Figure 11 shows that over most of the areas, the use of GIS has not reached the levels intended - shown by lower percentages in Figure 11 compared to Figure 10. This could be related to unfamiliarity with the new technology and presently a lack of skills in this area. Ireland [1994] referred to the cost of GIS and the lack of personnel as being key factors inhibiting GIS implementation.

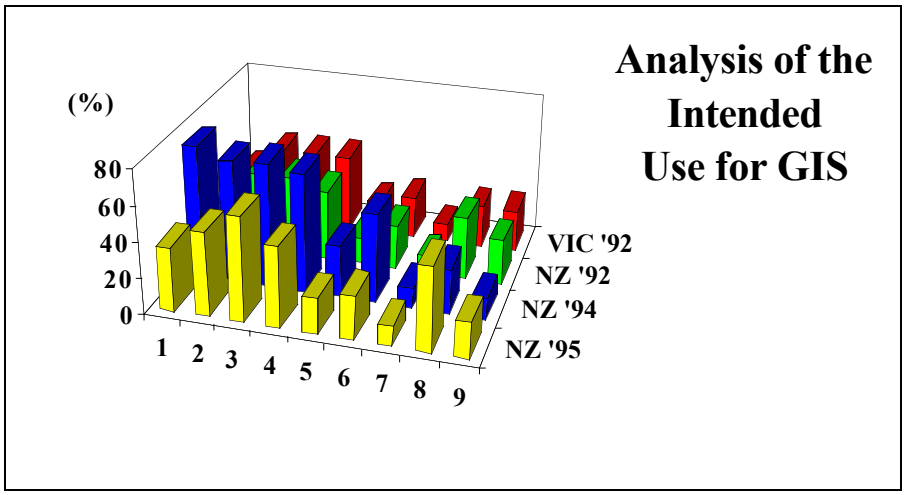

Figure 10: Analysis of Intended Use of GIS

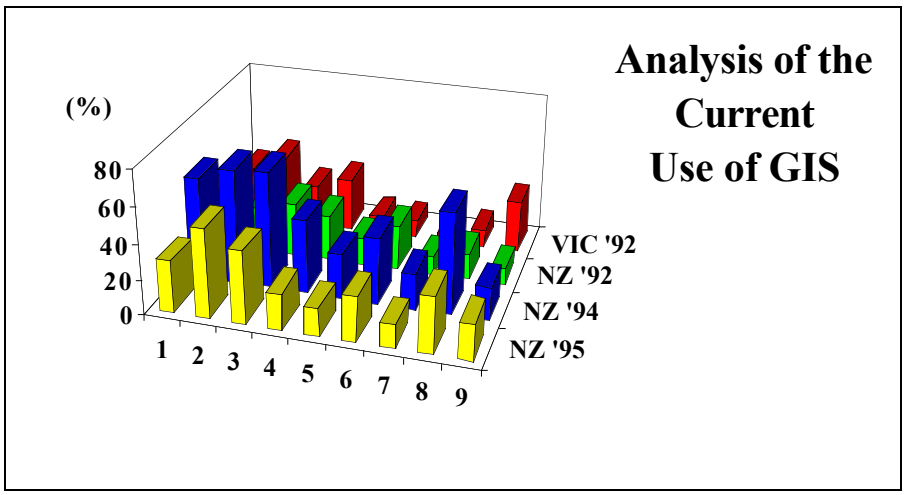

Figure 11: Analysis of Current Use of GIS

KEY
(Figures 10 and 11)

1. Resource Map Production
2. Planning of Zoning Maps
3. Facilities Management
4. Land Use Analysis
5. Transportation Analysis
6. Census Data Analysis
7. Delivery of Emergency Services
8. Site Analysis
9. Other

Many central government agencies are holders of vast quantities of spatial data (Figure 3). Figure 12 shows that the vast majority of local government respondents indicate that central government has a responsibility in the development of GIS. Respondents were asked to list up to three important issues which were then categorised based on content into four areas shown below. Issues that were more prevalent were functions of creating standards/integration of data and the supply of data to local government organisations.

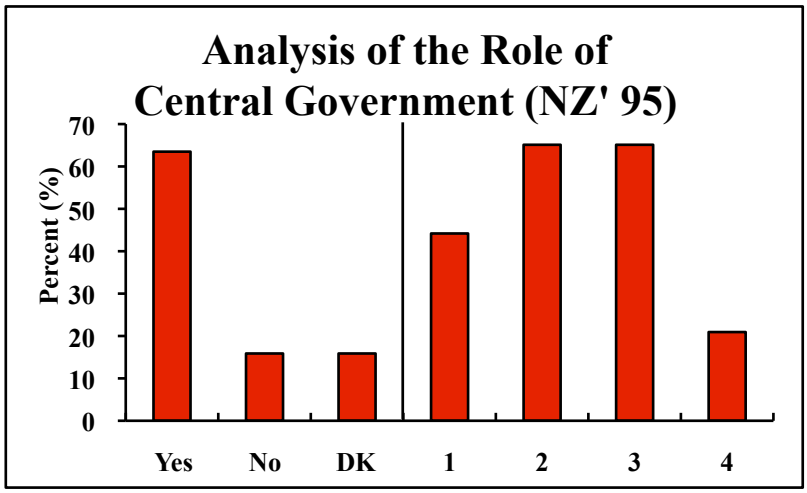

Figure 12: Analysis of the Role of Central Government (NZ'95)

KEY
(Figure 12)

1.	Research, Leadership and Help	3.	Supply of Accurate Data
2.	Standards and Compatibility	4.	Cost of Data

DK = Don't Know

Figure 13 shows a summary of the types of issues the respondents feel need to be addressed. The respondents were asked to list up to five issues which were then categorised based on content. The need for further work in the areas of asset management and data integration were highlighted.

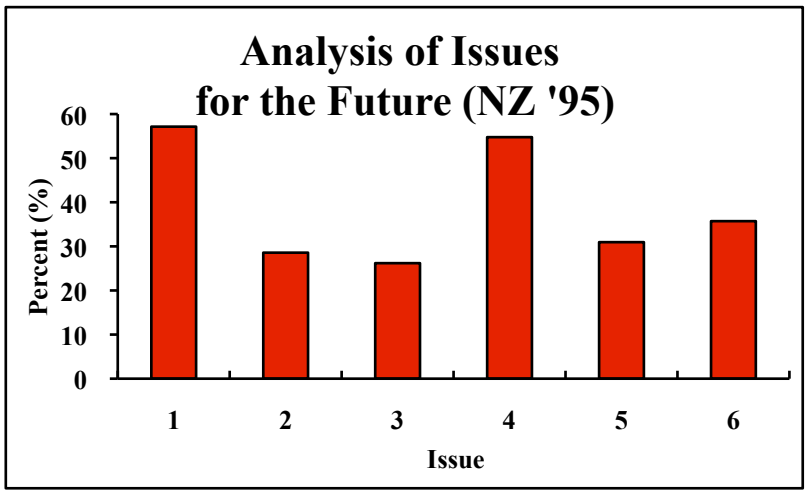

Figure 13: Issues for the Future (NZ'95)

KEY
(Figure 13)

1.	Asset Management	4.	Data Integration
2.	Data Capture	5.	Resource Management/Planning
3.	Application Development	6.	Land Information Development

It was determined by [Craig, 1994] that every city in Minnesota with 40,000 or more people was using GIS. In New Zealand, local authority population bases vary from less than ten thousand to more than 450,000 (based on survey results). It is acknowledged that for most, depending on size, GIS would be beneficial, but for some smaller authorities, paper based systems may be the most practical approach in the short to medium term. Figure 14 shows all respondents with a population base less than 50,000. All responding organisations above this figure have GIS. Figure 14 shows that GIS is well distributed among all population bases, even at the lower levels. The right hand side of the graph includes a number of respondents that have GIS, and a very small number that don't. This suggests that these organisations could benefit from GIS, since it has been adopted by other similarly sized authorities.

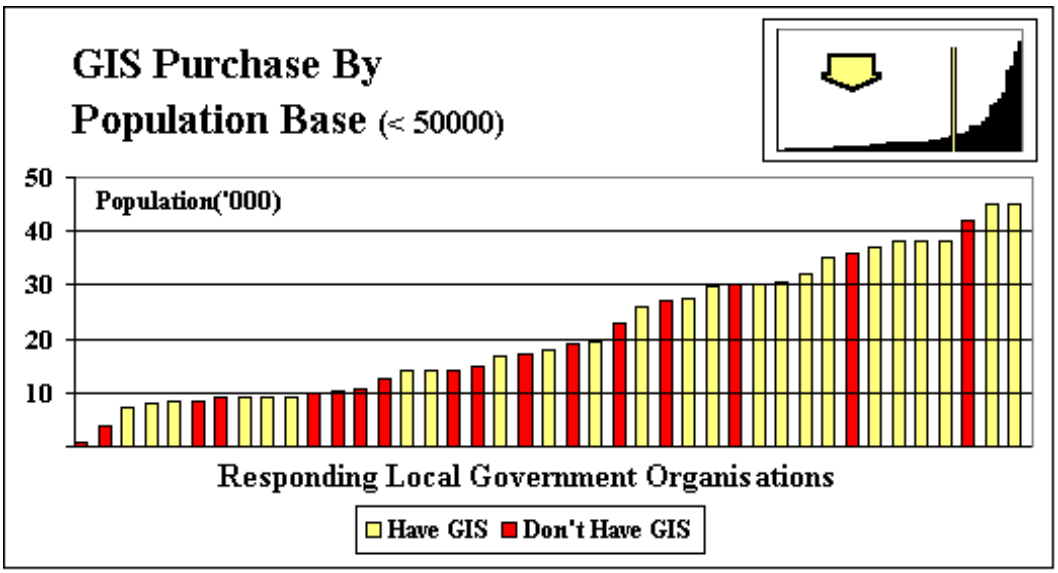

Figure 14: GIS Purchase by Local Government Organisation
with a Population Base less than 50,000 (NZ'95)

3 Discussion

From the analysis of the above data it is possible to conclude the following.

- The amount of data being captured digitally is increasing, and is predicted to increase dramatically, as technology becomes cheaper and more sophisticated. This is particularly true in the areas of data capture and field surveying techniques.

- There has been a large increase in the number of organisation purchasing GIS, particularly evident in 1994. Reasons range from solving identified problems to 'it seemed a good thing to do'. Most government bodies are under pressure to fulfil requirements of the New Zealand Resource Management Act, the Building Act, and the Local Government Act [Boot, 1995]. Other influences relate to the need to justify asset management expenditure. It would appear as if 1994 was a major turning point in terms of GIS with local authorities feeling the time was right to invest in GIS.

- Many organisations purchased GIS to complete a wide range of functions, but in most cases, the use of GIS is yet to reach the levels originally intended.

- Many sites purchase GIS for set purposes eg. engineering, but then expand its applications at a later date.

- Responses describe GIS at many different stages. Of the more experienced users, GIS was becoming more of a corporate system to enable access to corporate data.

- In keeping with the above, there is a marked increase in GIS being administered by the 'Information Services' unit as opposed to some other functional organisational unit.

- Most organisations had upgraded their hardware although there was nothing to directly indicate that this was a result of using GIS.

Most respondents consider that in terms of GIS, Asset Management and Data Integration are the main issues that need addressing in the future.

In 1974, Nolan and Gibson published a paper entitled 'Managing the Four Stages of EDP Growth', [Sprague, 1993]. This was based on studies in a wide variety of organisations at different phases of IS development. Although the findings were later questioned by Lucus and Sutton [Benbasat, 1980], the paper itself became a landmark for modeling IS implementation. The original 4 stage model was later modified with two new stages being added [Nolan, 1979], but the concept remained the same.

Nolan stated that an 'S' shape curve reflected how an organisation learns to assimilate new electronic data processing technology. Based on the curve, four stages in this process were identified (Figure 15). The description of each stage was modified by McFarlan and McKenney [Sprague, 1993], because the Nolan descriptions appeared to be negative, particularly at stage two where it was felt that the stage was more of a positive occurrence in the development cycle [Sprague, 1993].

	Nolan and Gibson	**McFarlan and McKenney**	**Description**
1.	Initiation	Identification and Initial Investment	Slow Steady Growth
2.	Contagion	Experimentation and Learning	High Exponential Growth
3.	Control	Management Control	Absolute Declining Growth
4.	Integration	Widespread Technology Transfer	Managed Steady Growth

Figure 15: Comparison of Stage Labels based on the Nolan Model

It is suggested [Cash, 1994] that the stage theory can be applied to a number of eras as the developments in IT have been adopted and gained widespread acceptance. It is recognised that these eras may overlap as organisations retain older technologies but begin to experiment with the newer technologies.

The advent of GIS is a specialist subset of IS with its own era and ‘S’ curve model. It is possible to see that the last stage of the model in the case of GIS represents maturity and possible integration with mainstream IS operations, i.e a fully corporate system.

The extra functionality GIS offers may then be described as an addition to, not as something apart from, present day computing

[Zwart, 1992 p5]

Analysis of the results overall tends to suggest that the development of GIS is maturing. In an attempt to map an organisation's position on the development path, respondents were asked to plot their stage of GIS development on a time-line (Figure 16). The majority of respondents placed their organisation in one of four identified stages that follow the stages of GIS development (Figure 4). The stages of the Nolan 'S' curve were also included with its stages identified as **A**, **B**, **C, D**. With the two curves drawn side-by-side, comparisons could be drawn.

If this graph is taken one step further, it is suggested that as time moves on, the emphasis of the graph representing the four stages will also move on. This 'tidal wave', which is in keeping with the peak of GIS purchase (Figure 7), will have major implications for GIS development as a whole.

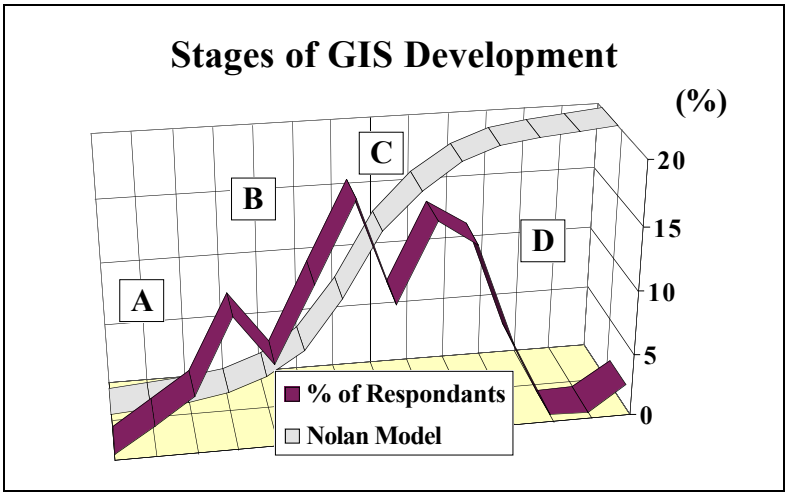

Figure 16: Stage of GIS Development compared with Nolan Curve (NZ'95)

4 Conclusions

It was suggested by [Bacon, 1992] that there were three preferred alternatives for organisation placement of GIS in New Zealand regional councils. The options were to have GIS as a separate entity under corporate services, have it as part of information services, or have a regional GIS unit responsible for GIS requirements of two or more separate organisations. It is not unreasonable to suggest that a similar structure could be adopted by other authorities. Regardless of which option is taken, it would seem imperative that for higher efficiency to be reached, all data must become an organisational asset as opposed to being maintained exclusively for the use of one or more functional units in the organisation. GIS should be seen as a tool (one of many alternatives) to access and assess the organisational data, whether spatial or non-spatial.

The spatial component is just another information system. But it sure adds power to the final product.

[White, 1995 p10]

GIS is a powerful analysis tool, but the efficiency from an organisational basis is dependent on the way it is used. The results of this survey indicate that some organisations are reaching the end of their initial GIS development programmes as they relate to the pre-defined Nolan model for IS assimilation which indicates that in some areas peak efficiency in this regard is being reached.

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