Understanding the Spatial Variability of Borderline Disorders using GIS in a Mental Health Environment

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ABSTRACT

Waikato District Health Board Mental Health Services provide mental health services to people from the tip of the Coromandel across the Waikato District and down the King Country, a total population of some 317,751 (as at the 2001 census). The Service employs some 500 staff across multiple disciplines and the patient management systems have over 11,000 service users currently assigned to mental health teams. The Service operates in an environment where the privacy of information ranks equally with the clinical need to share that information. Government policy requires equity of access for all service users, however over a third of the target population lives in Hamilton, arguably the fourth largest urban area in New Zealand, whilst the remainder live in disbursed, sometimes isolated rural communities. It is against this backdrop that the need to gather data and dispense information arises. The Mental Health Service originally stumbled onto GIS systems in an effort to more accurately depict the borders of areas served by its community mental health teams and continues to discover additional utility on an ongoing basis. Early attempts at resource allocation used guestimates to arrive at the staffing complements required for particular teams. In 1997 population estimates by Territorial Local Authority were used to determine roughly equivalent service areas for integrated multidisciplinary teams, so that teams of 18 staff served populations of approximately 60,000. When a review of those boundaries was performed in 2002, using GIS systems to accurately identify the boundaries of service areas and correlate those boundaries with usually resident populations, it was found that an equal population distribution no longer existed. Future development paths for this work will include the geo-coding of the residential locations of existing clients and then incorporation of travel time information so that more equitable resource allocation can be made during service planning. Another path being developed is the plotting of referral data and crisis incident data. Early review of the data has shown a number of unexpected results, giving rise to a re-assessment of the data being collected. Thus the use of GIS systems to depict data has also become a method of checking both the integrity of that data and assumptions used in determining what data is to be collected. The aim of this paper is thus to show how the introduction of GIS has assisted in the visual communication of spatial data related to mental health service provision, resource allocation and service planning. It follows the development of maps from the early use of simple diagrams developed in MS Word© to the use of ESRI's ArcMap© software, which introduces the concept of interactive data representation. The paper outlines the progress being made by staff

within the Mental Health Division to gain competency in the development and use of these tools.

***Keywords and phrases*:** introduction, development, mental health, service provision, resource allocation, service planning.

1.0 INTRODUCTION

The aim of this paper is to show how the introduction of GIS has assisted in the visual communication of spatial data related to mental health service provision, resource allocation and service planning. It follows the development of maps from the early use of simple diagrams developed in MS Word© to the use of ESRI's ArcMap© software, which introduces the concept of interactive data representation. The paper outlines the progress being made by staff within the Mental Health Division to gain competency in the development and use of these tools.

1.1 Waikato District Health Board Mental Health Service Demographics

Waikato District Health Board Mental Health Services provide mental health services to people from the tip of the Coromandel across the Waikato District and down the King Country, a total population of 317,751 (2001 census data, Statistics NZ). The Service is structured into three Clinical Service Streams across 5 major service groupings (Adult Mental Health Services [AMHS], Regional Forensic Psychiatric Services [RFS], Child and Adolescent Services [C&A], Alcohol and Drug Services[A&D] and Mental Health Services for Older People [MHSOP]). These services employ in excess of 500 staff across multiple disciplines, from Specialist Psychiatrists to administration staff. The patient management systems have over 11,000 service users currently assigned to mental health teams across these services, however a number of these patients may in fact not have been seen for some time. The Service operates in an environment where the privacy of information ranks equally with the clinical need to share that information. Government policy requires equity of access for all service users, however over a third of the target population lives in Hamilton, arguably the fourth largest urban area in New Zealand, whilst the remainder live in disbursed, sometimes isolated rural communities. It is against this backdrop that the need to gather data and dispense information arises. Whilst most of the Waikato District Health Board's services operate only across the defined WDHB District the Regional Forensic Psychiatric Service provides regional coverage across the Central North Island, which includes the Bay of Plenty, Lakes and Taranaki District Health Board areas. Their prime focus is assisting the Justice system by way of Court Liaison, conducting clinics in Prison(s) and providing secure inpatient facilities in Hamilton. The total population across the four DHB's 731,000 (2001 census data, Statistics New Zealand)

2.0 EARLY ATTEMPTS TO REPRESENT SERVICE BOUNDARIES

The first attempts by the one of the authors to show service boundaries occurred in 1996 when a map representation was included in the Service Business Plan. The only electronic map of New Zealand found at that time was sourced off the Internet from an American tourism site. The Map was relatively basic and the modifications to it to represent the areas serviced by the Mental Health Division even more basic (Figure 1).

Figure 1: First attempt at representing Health Waikato & Midland Health Boundaries Circa 1996

The next attempts used even more basic maps, original source unknown, but included an attempt to represent not only the service area of the Waikato District Health Board, but include a representation of the service boundaries of the Adult Mental Health Service's Community Teams (Figure 2). These latter diagrams had very rough approximations of city and town locations and service boundaries, again all drawn by hand using MS Paint.

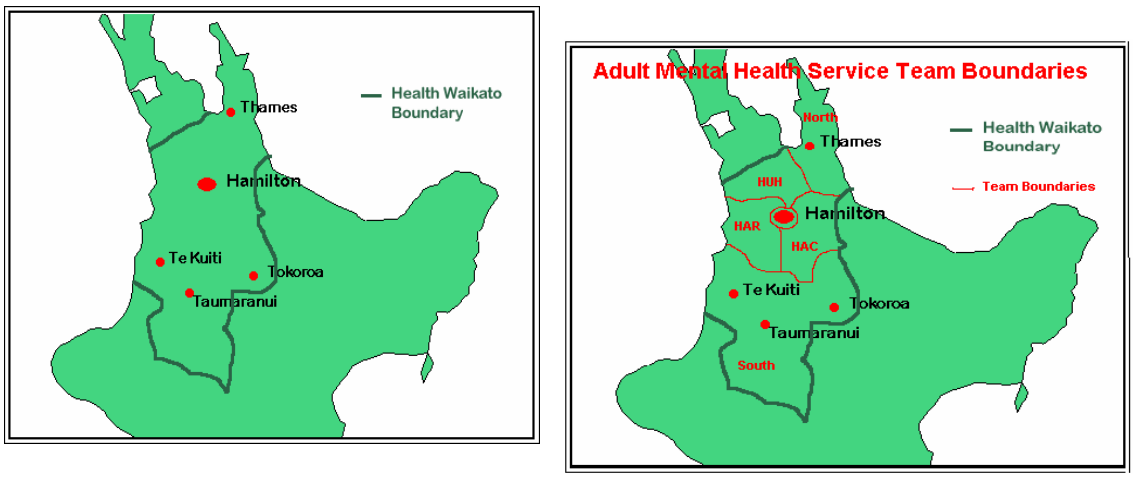

Figure 2: Second attempts at Boundary Representation, AMHS service boundaries, Circa 1997

In 1999 a Health Funding Authority Document included a Land Survey Department Map of the central North Island, which included Crown Health Enterprise (CHE) boundaries. This was in Bitmap format and was inserted into MS Word and modified using Word drawing objects to represent service bases and outreach offices. The Map.BMP and the word objects were then all selected and grouped to form a single MS word drawing object (Figure 3).

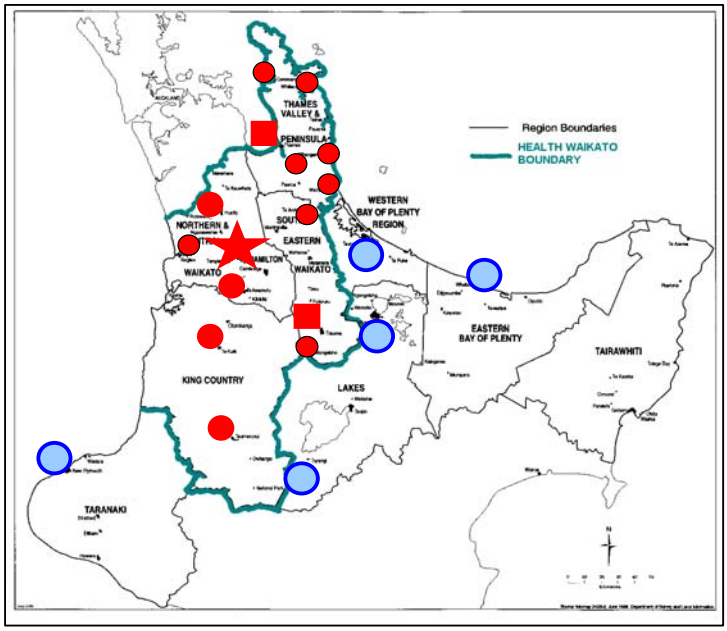

Figure 3: Third attempt: Bitmap and MS Word objects grouped

This map is still in use in the current Service Plan for 2002-2003.

3.0 INTRODUCING GIS TO THE MENTAL HEALTH SERVICE

In June 2000 the Mental Health Division became aware that Public Health Unit of the Waikato District Health Board had the services of a GIS Analyst, and after initial discussions recognised the enormous potential of GIS as a multi-faceted tool for the service.

3.1 Phase I: Re-determination of (AMHS) Boundaries

The first project undertaken in conjunction with the GIS Analyst was the re-determination of AMHS Community Team Boundaries. A Mental Health analyst, using population estimates for Territorial Local Authority (TLA) areas originally set these boundaries in 1996/1997. The purpose was to determine roughly equivalent service areas for integrated multidisciplinary teams, so that teams of 18 staff served populations of approximately 60,000. No maps were provided, but team leaders were advised of the TLA areas that they were expected to serve.

The Mental Health Services Co-Ordinator worked with the AMHS Team Leaders to determine team boundaries using AA road Maps (Figure 4)

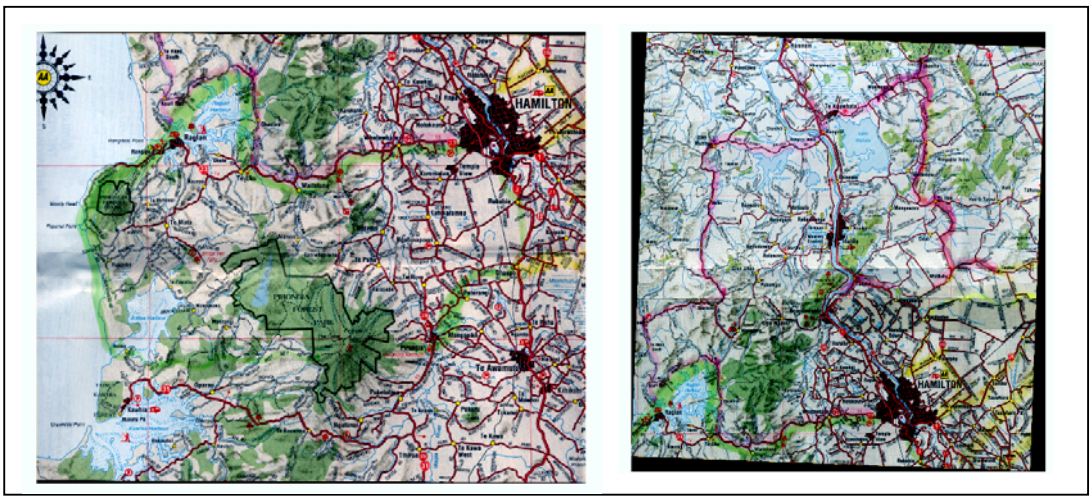

Figure 4: AA Maps with highlighted Team Boundaries ready for digitising

When all Team leaders were in rough agreement, the results were digitised. The boundaries were then modified to align with census mesh block boundaries in order to use the underlying population data in each mesh block. Following this, initial concept or working maps were produced incorporating sub-regional population data (Figure 5)

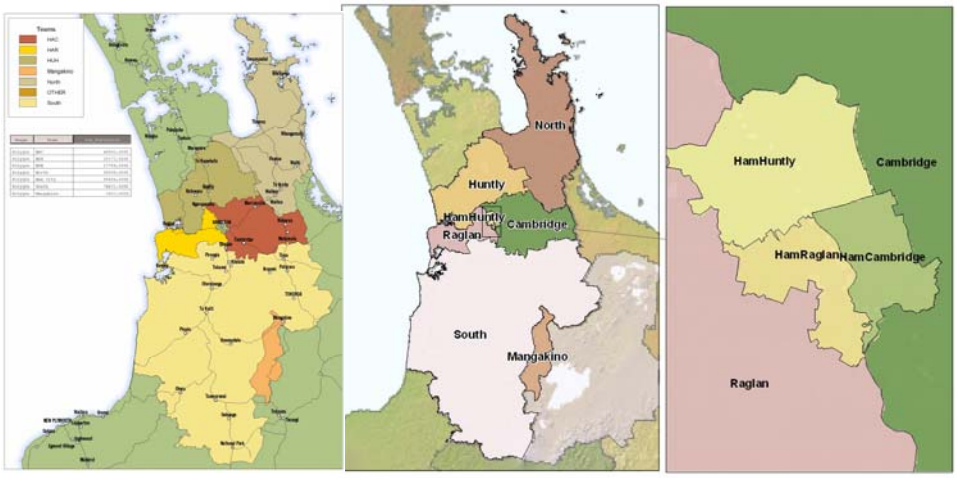

Figure 5: Maps representing team boundaries including tabulated sub-regional population data

Initial review indicated that populations served no longer equated to the 60,000 population split on which the teams were structured. Much of this was also caused by the team design concept, which allowed for service users within the Hamilton City environs to remain with their initially allocated team as long as they remained within city boundaries (This was to ensure continuity of care and consistency in practice). The Final Map produced for use by teams is shown in Figure 6.

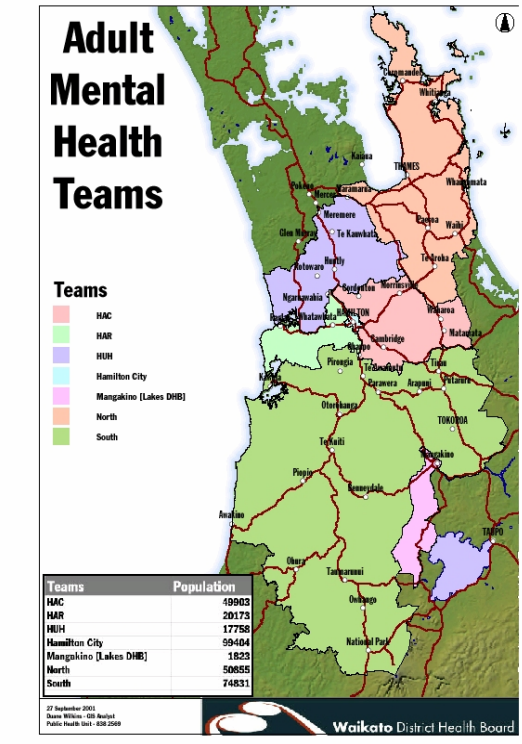

Figure 6: Final AMHS Team Boundaries

3.2 Phase II: Regional Forensic Psychiatry Services and Crisis Assessment and Treatment Services

Based on the utility shown in the preparation of the AMHS maps the Mental Health Division applied for and had approved the purchase of high-end laptop and a copy of the ESRI software (V8.1). The GIS Analyst then created a number of base maps using existing data held by the DHB.

In response to a request from the Regional Forensic Service and as a training example a map was prepared indicating the location of courts, prisons and areas of service provision by both the Regional Forensic Service and the local Kaupapa Māori Forensic Mental Health Service, Hauora Waikato (Figure 7)

Figure7: Regional Forensic Psychiatric Service Provision with Courts and Prison locations

The next aspect to which the Mental Health Service applied GIS, was the collection of referral data to the Hamilton AMHS Community teams and the details of Crisis Assessment and Treatment (CAT) Call outs over a 9 month period ended 30 June 2002.

Patient level data from both data sets was geo-coded and resulted in some unexpected results. In both the referral data set and the CAT callout data set, data points outside of the Waikato District Health Board region were noted (Figure 8)

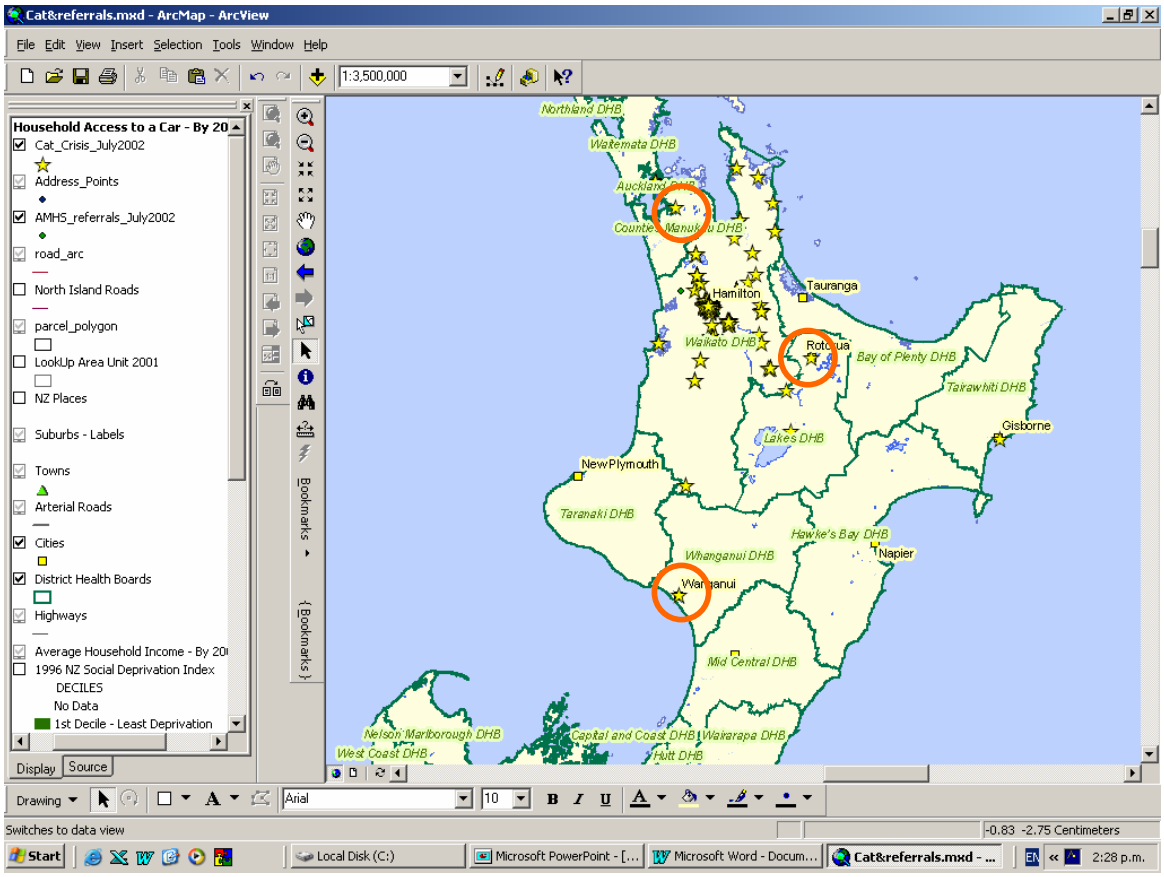

Figure 8: Printscreen CAT Callouts and AMHS Hamilty Community Team Referrals 1

On investigation, the "out of region" CAT Callouts arose as the data recorded was the "usually resident" address of the service user in crisis, not the location to which the CAT service were called to deliver the service. While it is useful at to retain patient level demographic data, the research is somewhat flawed as there is no record of where the CAT were called or the frequency of calls to particular areas. The data can not thus be used to assess whether the service needs to be delivered differently in order to improve response times or whether the size the team should be modified or based in different locations or whether the Service should apply any other resource allocation priorities.

Within the AMHS Community referral data set, there was only one out of region referral highlighted. This was from Rotorua. As the address was a Rimu Street address checking was required, as this may have been a geo-coding error. Investigation within the referral database established that whilst the "permanent" address of the referee was Rotorua, the individual actually spent week days in Hamilton and had requested to be seen by the Hamilton services. The referral was thus reasonable.

The next element that was included was the levels of household income (Health Visual Census, Critchlow & Associates). This shows prima facie evidence of a strong correlation between incidents of psychiatric crisis and mid to low levels of household income.

Because most of the organisations printers were black and white only, initial advice was to maintain monochromatic colour ramping to display the variances in household income. It was interesting to note that high

contrast multicoloured colour ramps provided a better impact for differentiation of income bands, both on screen and with black and white printing (Figure 9).

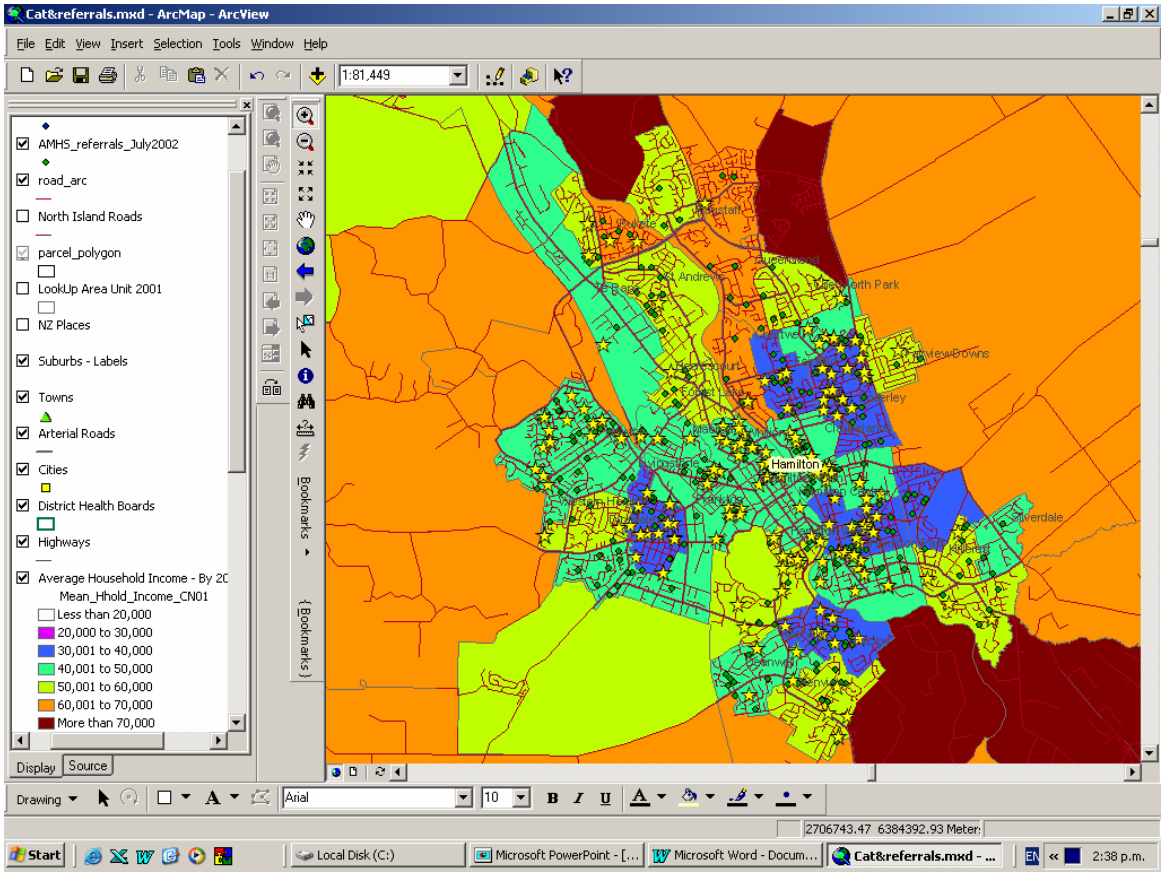

Figure 9: Impact of high contrast colour ramping in differentiating CAT Referrals and Household Income Levels

The Information was presented to the CAT Service at a recent planning day using ArcMap and not Powerpoint. This produced high levels of enthusiasm and requests for further collaboration in research projects. It is also hoped that the early presentation of these results will result in:

- higher levels of data integrity (as the team see the results of the data they collect);
- greater thought going into the research design (so that aspects such as where call outs occur are recorded)
- the database design incorporating geo-coded addresses from the outset.

3.3 Phase III: Future use in Resource Allocation

For sometime now the Mental Health Service has been reviewing the primary AMHS base in Hamilton with respect to its location, user friendliness and functionality. To assist our decision making process, attempts are being made to use GIS to facilitate the siting of an appropriate new base for the services currently delivered out of the existing site.

In order to provide some data on where the Mental Health Service's patients are in fact living, a dump of demographic data for all patients within our Patient Management System (PMS) was obtained. The first setback faced in this process was the fact that attempts to geo-code the data have met with certain difficulties relating to hardware failure. However it is hoped to use this information in future to produce different "layers" each relating to patients attached to a particular team and establish where the highest density of patients are located. Together with data related to access to motor vehicles (Health Visual Census01, Critchlow & Associates), public transport (Bus Timetables, Environment Waikato) and (potentially) travel time data, establish which locations would be potentially best meet the various criteria.

Initial coding and display of a subset of the data has allowed the potential of the above proposal to be used to further define design parameters. 1600 patients who have had a contact with the service in the past (but who are not currently in the service and therefore not assigned to a particular team) have been coded. The data has been presented in two ways, the first against aerial photographs (just to bring that extra bit of realism into the discussions) (Figure 10) and the second using patient density by census area unit (Figure 11).

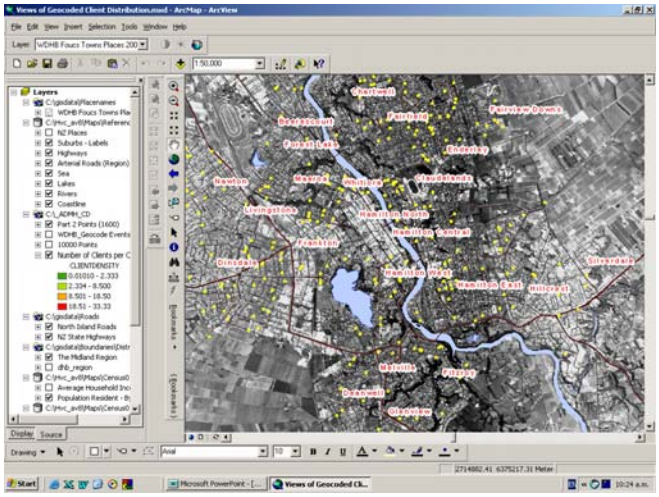

Figure 10: Hamilton City (ex-patients not currently seen by the service and thus not assigned to a team)

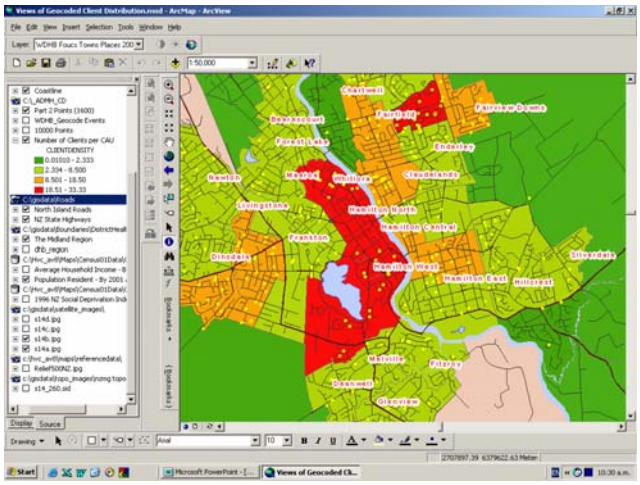

Figure 11: Hamilton City (Patient density by CAU of ex-patients not currently seen by the service and thus not assigned to a team)

The data details of 86 ex Tokanui Hospital patients who are no longer receiving services from Waikato District Health Board. Their addresses were modified to the address of the current mental health inpatient unit, the Henry Rongomau Bennett Centre. This has skewed the result, creating a higher population density for the neighbourhood than would otherwise have been the case.

Another challenge encountered was an inability to simply overlay public transport routes, as Environment Waikato (EW) does not use compatible GIS systems. However, EW does have internet styled "hot-links" to various bus routes and timetables (Figure 12) and, should this aspect come into the final evaluation criteria, these sites will be viewed outside of the final ArcMap presentations to Management.

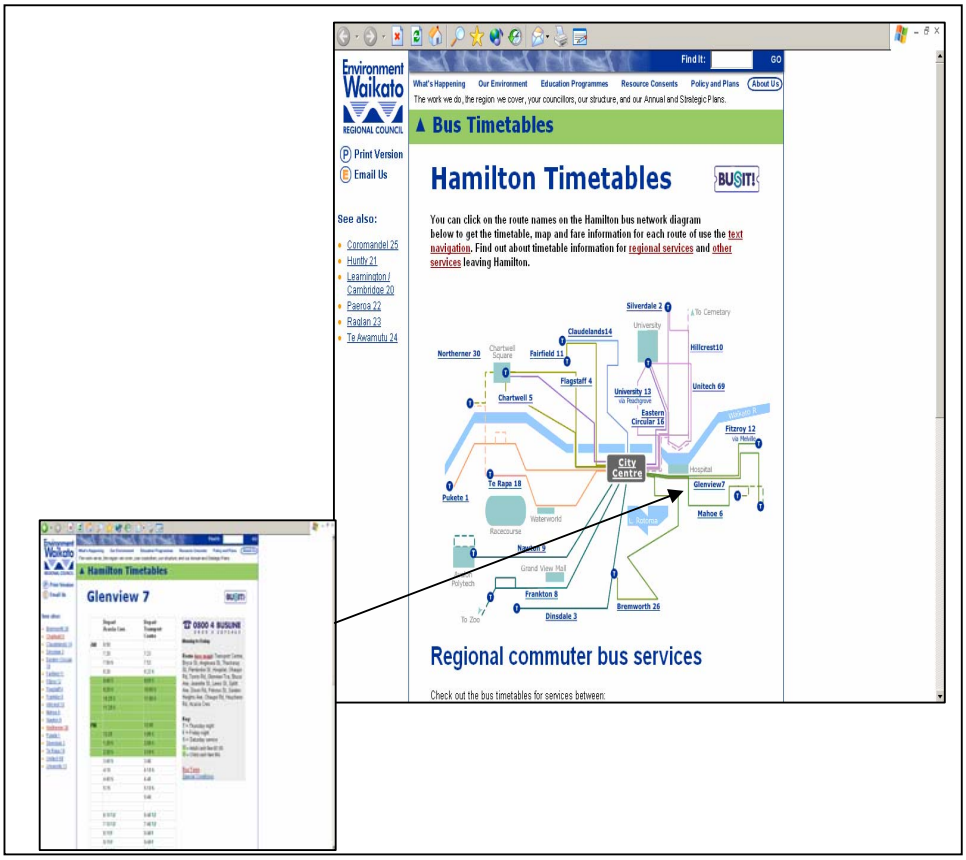

Figure 12: Environment Waikato Bus timetables with hotlinks

4.0 LESSONS LEARNED

This paper outlines the current stage of infancy in the use of GIS systems within the Mental Health environment, at Waikato District Health Board. We realise we have a long way to go to become adapt or even proficient in the use of the powerful tools now at our disposal. We have, however, learned some useful things to date that the more experienced reader may wish to be reminded of:

Early feedback of data through GIS can

- assist in checking data integrity
- assist in checking research model design
- build enthusiasm for the research model

Patient data privacy has different implications for presentation to different audiences

- Data/Information for use with the broader service environment needs to be anonymised
- Specific service use may require accurate portrayal of patient data
- There is an impact on accuracy levels required for geo-coding and some highly accurate data may need to be modified to remove those levels of accuracy

ACKNOWLEDGEMENTS

This paper could not have been prepared without considerable assistance from Duane Wilkins who has been mentor, coach, and slave. He has built a foundation of maps and interest from which we hope to progress in the future.

The writer would also like to acknowledge support of Environment Waikato, who have allowed Duane to continue to coach and spoon feed the Mental Health team after he transferred to their employment.

Our sympathies now lie with Wendy Black, the new GIS Analyst at Waikato District Health Board, who will also be pestered for information, advice and tutoring and who kindly reviewed this paper and advised on areas in which it could be improved.

Many of the maps currently being used and prepared include data from national data sets prepared or funded by the Ministry of Health.

Whilst the work of Lars Brabyn and Chris Skelly has been referred to, it has not yet been incorporated into any of the work done by the Mental Health Service yet. Attempts may be made to incorporate aspects of travel time into the siting of future Mental Health bases. Assistance will be sought in this process.

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