Using SAS to map petroleum distributions

Saskatoon SUCCESS SAS User Group

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FCL Background

- Wholesaler for over 300 retail Co-operatives with over 1,000,000 retail members.
- Distribution warehouses in Winnipeg, Saskatoon, Calgary and Edmonton.
- 7 Feed plants in Saskatchewan and Alberta.
- 130,000 bbl/day Heavy Oil Upgrader and Refinery Complex in Regina

SAS at FCL

- FCL’s has been using SAS since the early 1980’s

- Currently use SAS for:
  - Reporting
  - Data manipulation and preparation
  - Data warehouse
  - Statistical analysis

From here….

….To Here (700+)

Petroleum distribution planning

- FCL uses a linear program (LP) to optimize petroleum distributions.
- We have a number of ‘exchange agreements’ with different partner companies throughout western Canada.
- The goal of the LP is to find the most economical plan to meet required distribution volumes, given:
  - 1.exchange costs
  - 2.volume limits at each supply point.

Petroleum distribution planning (example)

- Consider a petroleum site in Medicine Hat.
  - Costs 3.5 c/L to ship there from Regina.
  - Costs 1.5 c/L to ship there from Calgary, but Calgary supply source incurs a 1.0 c/L additional ‘exchange differential’ surcharge.
    - Total cost = 2.5 c/L from Calgary.

- Ideally, we would supply this account from Calgary (if there is supply available).

Petroleum Distribution Map

- Goal of the map is to visually display the distribution plan.
- Main benefits:
  - 1. Identify any potential mistakes in the planning system (ie. Supplying an Alberta account from Winnipeg)
  - 2. Visualize the edges of each supply point shipping ‘orbit’.
  - 3. Visualize the effect that existing exchange contract limits are imposing on our distribution.

The Map

- Maps are generated automatically during each distribution LP run:
  - SAS program is called from Excel Visual Basic, via SAS Integration Technologies.
  - PDF file is automatically regenerated.

Required data:

- Data is split into three logical groups:
  - SAS Maps – by province.
  - Supply point cities.
  - Plot points, color driven by source location.

- Other data considerations:
  - Split supply – which point to plot?

Proc Gmap

```
Proc GMap
    Map=FinalMap Data=Fake ;
    Where Province in ('99' '35' '46' '47' '48' '59' '60' '61') ;
    Id province ;
    Choro number / discrete
                        nolegend
                        Annotate = OptimalSrceAll
                        coutline=black ;
Run ;
```

SAS Mapping Elements

- Proc Gmap statement
  - Map=
  - Data=
  - ID=
  - Annotate=
- Other mapping considerations
  - Radians vs. Degrees
  - Proc Gproject

Proc Gmap

```
Proc GMap
    Map=FinalMap Data=Fake ;
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    Id province ;
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Run ;
```

Map=

- Specifies the map dataset.
- Is the map outline only.
- Expected variable names:
  - ‘X’ and ‘Y’
  - Variable defining different map areas (Province)

Map=

	Unprojected Longitude in Radians	Unprojected Latitude in Radians	DENSITY	RecType	Province Segment Number	Province Abbreviation
1	0.3247506742	-0.236995437	6	Maps	1	35
2	0.3240224279	-0.237880519	6	Maps	1	35
3	0.3234327266	-0.239372731	6	Maps	1	35
4	0.3227369732	-0.240130283	6	Maps	1	35
5	0.3212280573	-0.241079187	6	Maps	1	35
6	0.3200849593	-0.241532818	6	Maps	1	35
7	0.3193288476	-0.242313818	6	Maps	1	35
8	0.3186400357	-0.243269419	6	Maps	1	35
9	0.3171284966	-0.245213241	6	Maps	1	35
10	0.3165027393	-0.246158146	6	Maps	1	35
11	0.3159492298	-0.247048322	6	Maps	1	35
12	0.3149680926	-0.249847552	6	Maps	1	35
13	0.3148180478	-0.250554899	6	Maps	1	35
14	0.3141493424	-0.251536375	6	Maps	1	35
15	0.3131495334	-0.254181531	6	Maps	1	35
16	0.3127847511	-0.255317482	6	Maps	1	35
17	0.3125736323	-0.256169949	6	Maps	1	35
18	0.3122404094	-0.256797657	6	Maps	1	35

Proc Gmap

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    Map=FinalMap Data=Fake ;
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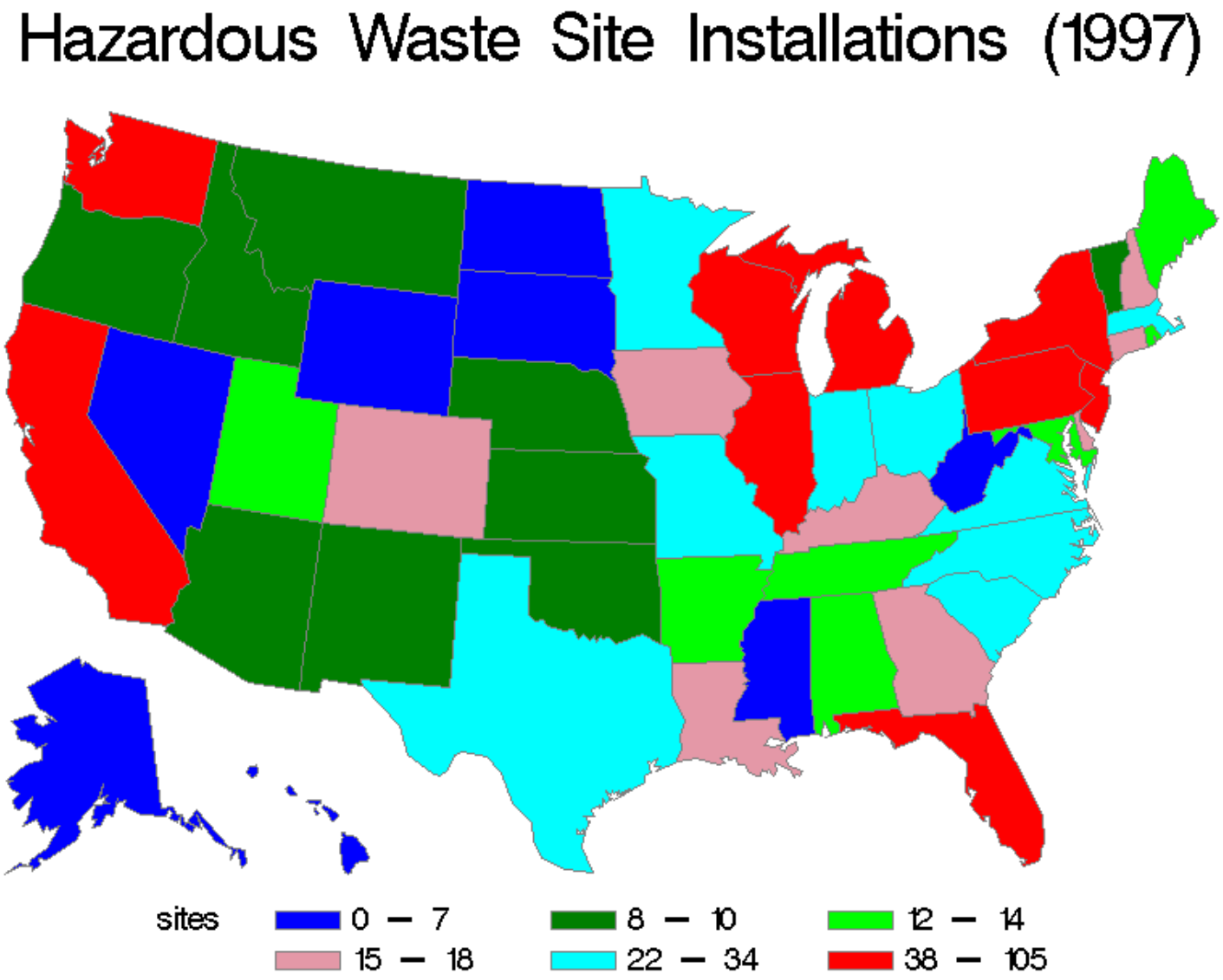
    Id province ;
    Choro number / discrete
                        nolegend
                        Annotate = OptimalSrceAll
                        coutline=black ;
Run ;
```

Data=

- Specifies the ‘response’ data set
  - Data points correspond to the map objects included in the Map= dataset (in this case provinces).
  - Only the map areas with response values are shown on the map.
  - Contains any data that correlates directly with each map group

Data= …continued



Data= …continued

- My SAS code for the response dataset:

```
* Build fake data required for the response dataset (by Prov);
 Data Fake ;
  length province $ 2 ;
  input province $char2. ;
  number=1 ;
  cards ;
  35 46 47 48 59 60 61 ;
 Run ;
```

Data= …continued

	province	number
1	35	1
2	46	1
3	47	1
4	48	1
5	59	1
6	60	1
7	61	1

Proc Gmap

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    Map=FinalMap Data=Fake ;
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    Id province ;
    Choro number / discrete
                        nolegend
                        Annotate = OptimalSrceAll
                        coutline=black ;
Run ;
```

ID=

- Identifies the variable(s) that define map areas

- Every variable listed in the ID statement must appear in both the **Map=** and **Data=** data sets.

Proc Gmap

```
Proc GMap
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    Id province ;
    Choro number / discrete
                        nolegend
                        Annotate = OptimalSrceAll
                        coutline=black ;
Run ;
```

Annotate=

- This is the dataset that holds any additional information to be plotted on the map.
- In my case:
  - Cities
  - Distribution points
- This dataset contains information about how to plot each point:
  - Symbols
  - Colors
  - Labels / Label position

Annotate= ….continued.

- In this case, really just plotting labels:
  - function=label ;
  - For distribution end-points, text=‘*’
  - For supply points, text=‘City name’
- Other variables:
  - Position= where to place the label relative to the x/y co-ordinate.
  - Size=
  - Style=
  - Color=

Annotate= …continued.

	Fvw Supp Pt No	ShpQty3	Lat Degrees	Lon Degrees	ProvName	color	function	text	position	xsys	ysys	style	size
679	01.Wpg	1450.4872609	49.883	-97.150	MB	dark_yellow	label	*	c	2	2	simplex	1
680	02.Reg	90.314048978	50.450	-104.617	SK	dark_green	label	*	c	2	2	simplex	1
681	05.Edm	142.42111891	53.550	-113.467	AB	dark_blue	label	*	c	2	2	simplex	1
682	04.Carse	39.705042432	51.050	-114.083	AB	red	label	*	c	2	2	simplex	1
683	04.Carse	178.09442757	53.550	-113.467	AB	red	label	*	c	2	2	simplex	1
684	02.Reg	85.375914773	50.450	-104.617	AB	dark_green	label	*	c	2	2	simplex	1
685	05.Edm	602.23871354	53.517	-113.317	AB	dark_blue	label	*	c	2	2	simplex	1
686	01.Wpg	431.71117535	49.883	-97.150	MB	dark_yellow	label	*	c	2	2	simplex	1
687	02.Reg	2944.5942806	50.450	-104.617	SK	dark_green	label	*	c	2	2	simplex	1
688	02.Reg	4000	49.117	-105.517	SK	dark_green	label	*	c	2	2	simplex	1
689	02.Reg	1566.6585355	50.450	-104.617	SK	dark_green	label	*	c	2	2	simplex	1
690	02.Reg	2200.6387028	52.117	-106.633	SK	dark_green	label	*	c	2	2	simplex	1
691	02.Reg	1375.424535	50.450	-104.617	SK	dark_green	label	*	c	2	2	simplex	1
692	02.Reg	6758.5789943	55.067	-117.283	AB	dark_green	label	*	c	2	2	simplex	1
693	02.Reg	15301.411358	51.367	-110.467	AB	dark_green	label	*	c	2	2	simplex	1
694	02.Reg	1318.4077461	52.117	-106.633	SK	dark_green	label	*	c	2	2	simplex	1
695	02.Reg	6211.9265049	58.117	-103.150	SK	dark_green	label	*	c	2	2	simplex	1
696	02.Reg	758.12736037	49.133	-102.983	SK	dark_green	label	*	c	2	2	simplex	1
697	02.Reg	1460.4544201	50.650	-102.083	SK	dark_green	label	*	c	2	2	simplex	1
698	02.Reg	586.31933388	51.983	-105.883	SK	dark_green	label	*	c	2	2	simplex	1
699	02.Reg	1490.9189885	56.250	-117.283	AB	dark_green	label	*	c	2	2	simplex	1
700	02.Reg	104.99442917	51.050	-114.083	AB	dark_green	label	*	c	2	2	simplex	1
701	02.Reg	9104.2074873	50.450	-104.617	ON	dark_green	label	*	c	2	2	simplex	1
702	02.Reg	1459.303457	50.617	-104.617	SK	dark_green	label	*	c	2	2	simplex	1
703	02.Reg	349.6945413	52.450	-109.167	SK	dark_green	label	*	c	2	2	simplex	1
704	02.Reg	0.5579238018	48.400	-89.317	ON	dark_green	label	*	c	2	2	simplex	1
705	01.Wpg	234.65586771	49.883	-97.150	MB	dark_yellow	label	*	c	2	2	simplex	1
706	01.Wpg	.	.	.	MB	black	label	01.Wpg	c	2	2	swiss	0.75
707	02.Reg	.	.	.	SK	black	label	02.Reg	c	2	2	swiss	0.75
708	04.Carse	.	.	.	AB	black	label	04.Carse	c	2	2	swiss	0.75
709	05.Edm	.	.	.	AB	black	label	05.Edm	c	2	2	swiss	0.75
710	06.Van	.	.	.	BC	black	label	06.Van	3	2	2	swiss	0.75
711	07.Nan	.	.	.	BC	black	label	07.Nan	d	2	2	swiss	0.75
712	09.Kam	.	.	.	BC	black	label	09.Kam	2	2	2	swiss	0.75
713	11.Terr	.	.	.	BC	black	label	11.Terr	c	2	2	swiss	0.75
714	14.P Geo	.	.	.	BC	black	label	14.P Geo	c	2	2	swiss	0.75
715	22.T Bay	.	.	.	SK	black	label	22.T Bay	c	2	2	swiss	0.75
716	25.BarePt	.	.	.	BC	black	label	25.BarePt	c	2	2	swiss	0.75
717	26.Hatch	.	.	.	BC	black	label	26.Hatch	F	2	2	swiss	0.75

Other considerations

- Radians vs. Degrees
  - SAS map data sets are in radians
  - Must convert latitude/longitude from degrees to radians:

```
*Convert to radians ;
   d2r = atan(1) / 45 ;
   x = d2r * (lond + lonm / 60 ) ;
   y = d2r * (latd + latm / 60 ) ;
```

Other considerations

- Proc Gproject
  - Converts ‘spherical’ coordinates onto a two dimensional plane so they can be properly plotted by Proc Gplot.
  - SAS map data sets and latitude/longitude coordinates must be projected – they will not plot properly in raw form:

```
Proc Gproject Data=Combined Out=CombinedProj ;
  Id Province RecType ;
Run ;
```

Questions?

?