Climate Change Health Impact Assessments: Farmer Suicide and Drought Case Study.

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Aim

Climate Change Health Impact Assessments (CCHIA) need

- Workflow tools for data management and analysis
- Enhanced capacity for experimentation, reviews, revisions

General approach:

- historical exposure-response functions, control covariates
- future response with changed exposures and population at risk

Motivating Case Study: Climate/Suicide

- Suicide has been linked to climate in a variety of studies
- Climate change impact on mental health is a gap in knowledge
- Use methods to analyse the relationship between Drought/Suicide
- Estimate future Climate Change impacts

New Tools are Needed

- Restrictions on access to suicide data have increased recently.
- Growing concern about the **Replicability Crisis**, (Peng 2011, *Science*, 334).
- Access to data and analytic software addresses this.
- We built a safe Sever/Client IT environment.

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System Design

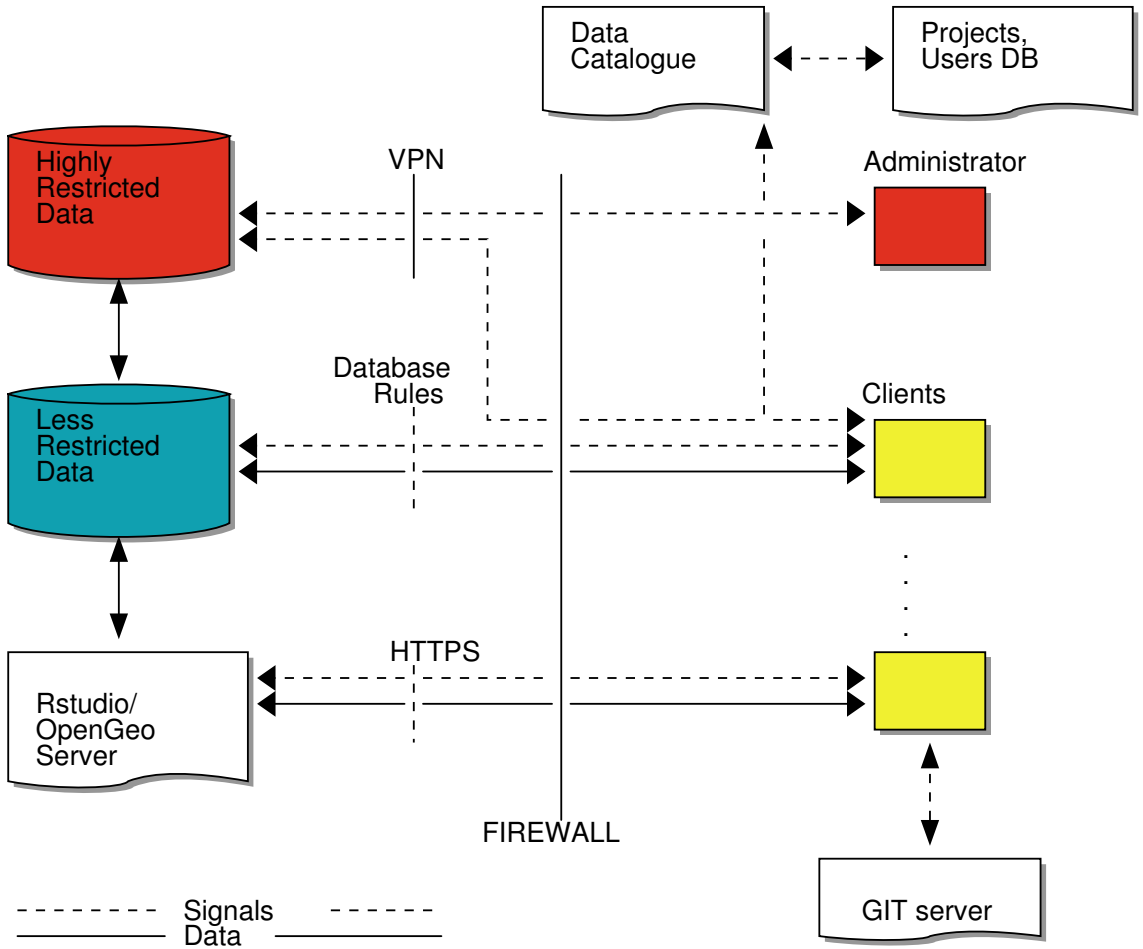

Figure: 1. System Design

Linux Cluster

- National Research Cloud (www.nectar.org.au/research-cloud)
- Centos 6.4 (www.centos.org)

PostGIS Database (The Brawn)

- PostgreSQL 9.2 (www.postgresql.org)
- PostGIS 2.0 (postgis.refractions.net)

Analysis (The Brains)

- R language for statistical computing (www.r-project.org)
- Rstudio server (www.rstudio.com/)
- OpenGeo Suite (opengeo.org)

Information Management

- Projects,UsersDB Oracle XE APEX (www.oracle.com)
- Data Catalogue (assda.anu.edu.au/ddiindex.html)

The Client Side

- The Kepler Project (www.kepler-project.org)
- pgAdmin (www.pgadmin.org)
- Git Version Control and GitHub (github.com)

Case Study: Historical

- Restricted Health and Drought data and
- Less Restricted Population data

(Colours refer to data storage and access rules shown in Figure 1).

$$
\begin{aligned}
log(O_{ijk}) \quad = \quad & s(ExposureVariable) + OtherExplanators \\
& + AgeGroup_i + Sex_j \\
& + SpatialZone_k \\
& + sin(Time \times 2 \times \pi) + cos(Time \times 2 \times \pi) \\
& + Trend \\
& + offset(log(Pop_{ijk}))
\end{aligned}
$$

Where:
O_{ijk} = Outcome (counts) by Age_i, Sex_j and $SpatialZone_k$
ExposureVariable = Data with Restrictive Intellectual Property (IP)
OtherExplanators = Other Less Restricted Explanatory variables
s( ) = penalized regression splines
$SpatialZone_k$ = Less Restricted data representing the $SpatialZone_k$
Trend = Longterm smooth trend(s)
Pop_{ijk} = interpolated Census populations, by time in each group

Case Study: Historical

Hanigan et al, 2012, *PNAS*, 109:

- 38 years suicide rates with drought by 11 regions, age and sex
- Estimated 9% in rural males aged 30-49 due to drought over the period
- Increased for rural males 10-29 y
- Association with hot temp + spring

Case Study: Future

Bambrick et al, 2008, Garnaut Review:

$$Y_{ijk} = \sum_{lm} (e^{(\beta_{ijk} \times X_{lm})} - 1) \times BaselineRate_{jkl} \times Population_{jklm}$$

Where:
β_{ijk} = the ExposureVariable coefficient for $zone_i$, age_j and sex_k
X_{lm} = Projected Future ExposureVariables with Restrictive IP
$BaselineRate_{jkl}$ = avgDeathsPerTime/avgPopPerTime in age_j, sex_k and $zone_l$
$Population_{jklm}$ = projected populations by age_j, sex_k, $zone_l$ and $time_m$ (With Less Restrictions)

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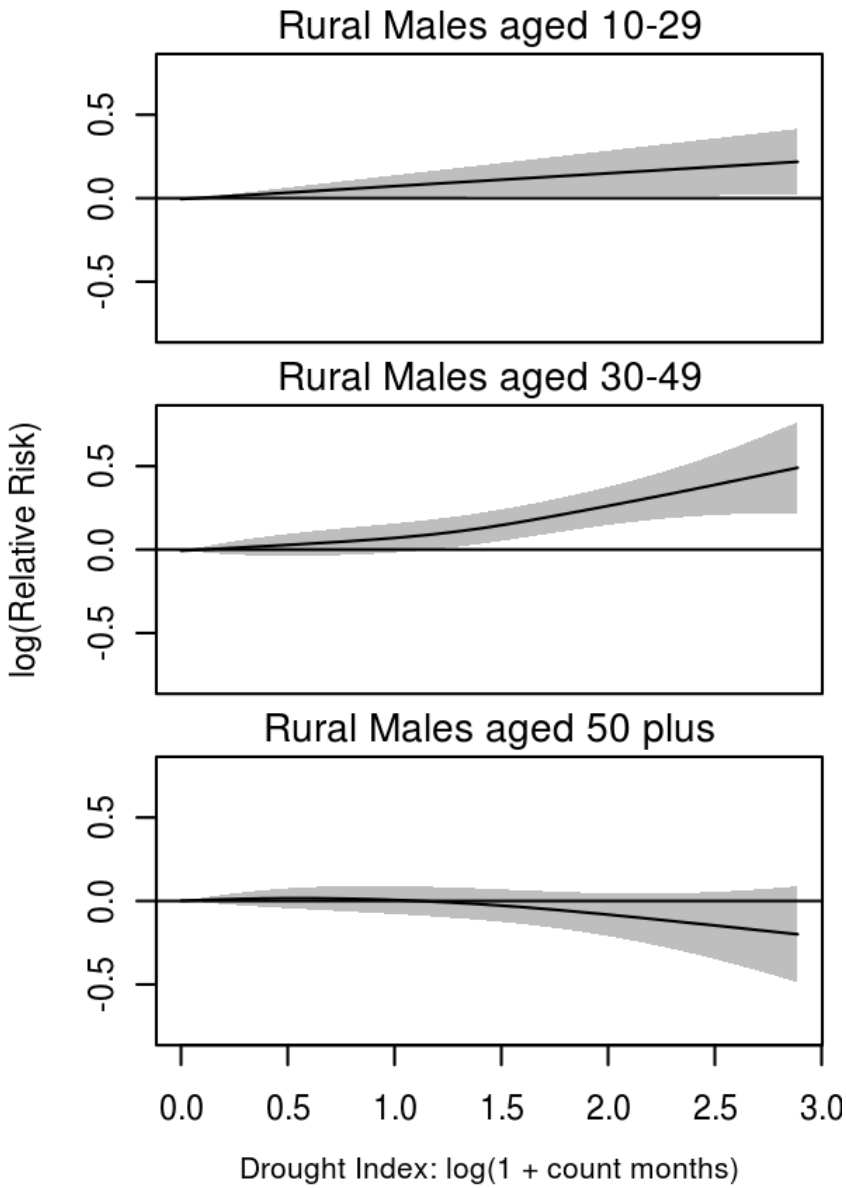
Drought-suicide response function



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Criticism

This model is too static, reductionist, reality is more complex. Need to work more on interactions with non-climate factors especially:

- Natural capital
- Financial capital
- Social capital
- Physical capital and
- Human capital

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Conclusion

- Drought is related to increased suicide risk in Australia
- Future Drought associated deaths can be calculated
- These estimates will be very uncertain, contentious and difficult to justify
- Data management and analysis technology such as that presented is needed to enable rigorous and transparent exploration

Conclusion

This system:

- Enables data analysis in a safe environment
- Allows comparison of multiple climate scenarios and assumptions
- Demonstrated with a Climate/Health Impact Assessment
- This is Reproducible

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