

# Predictive policing and the role of analysis: A framework for effective resource targeting

Dr Spencer Chainey

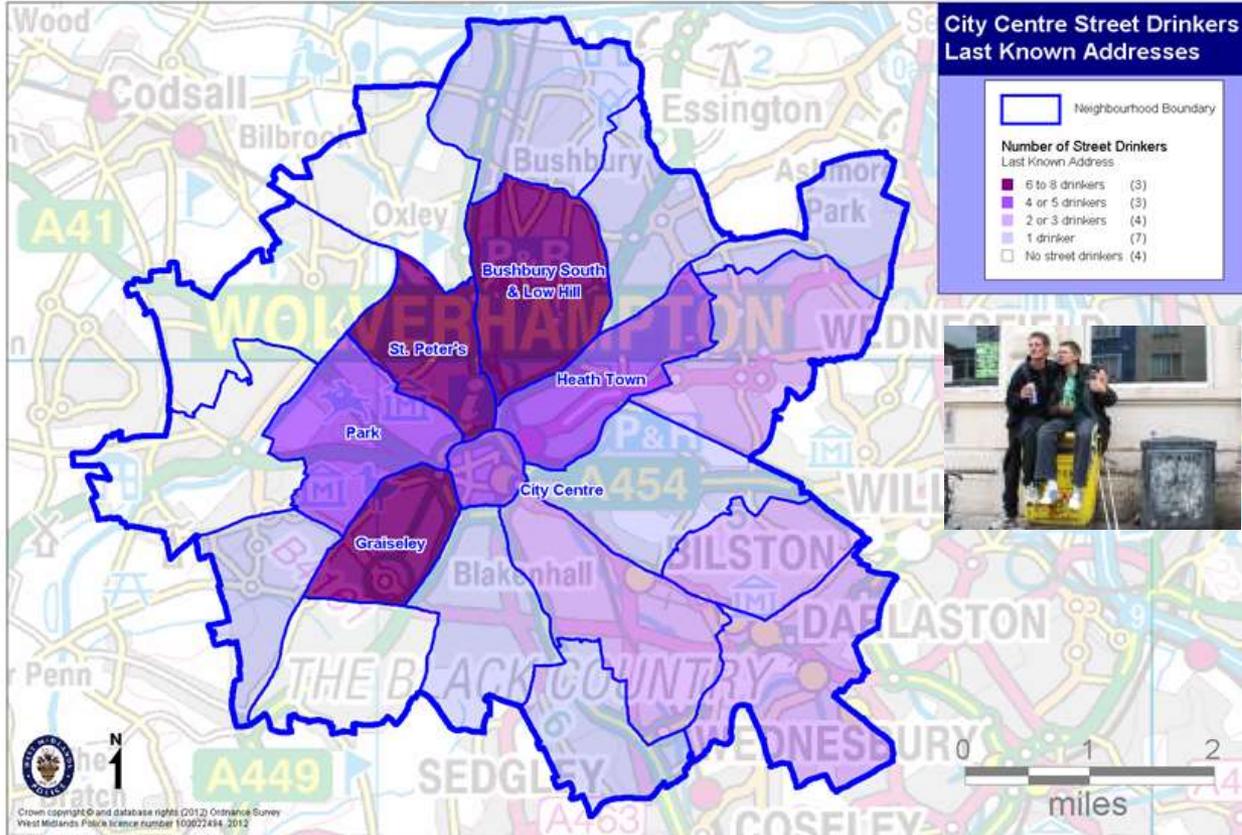


@SpencerChainey

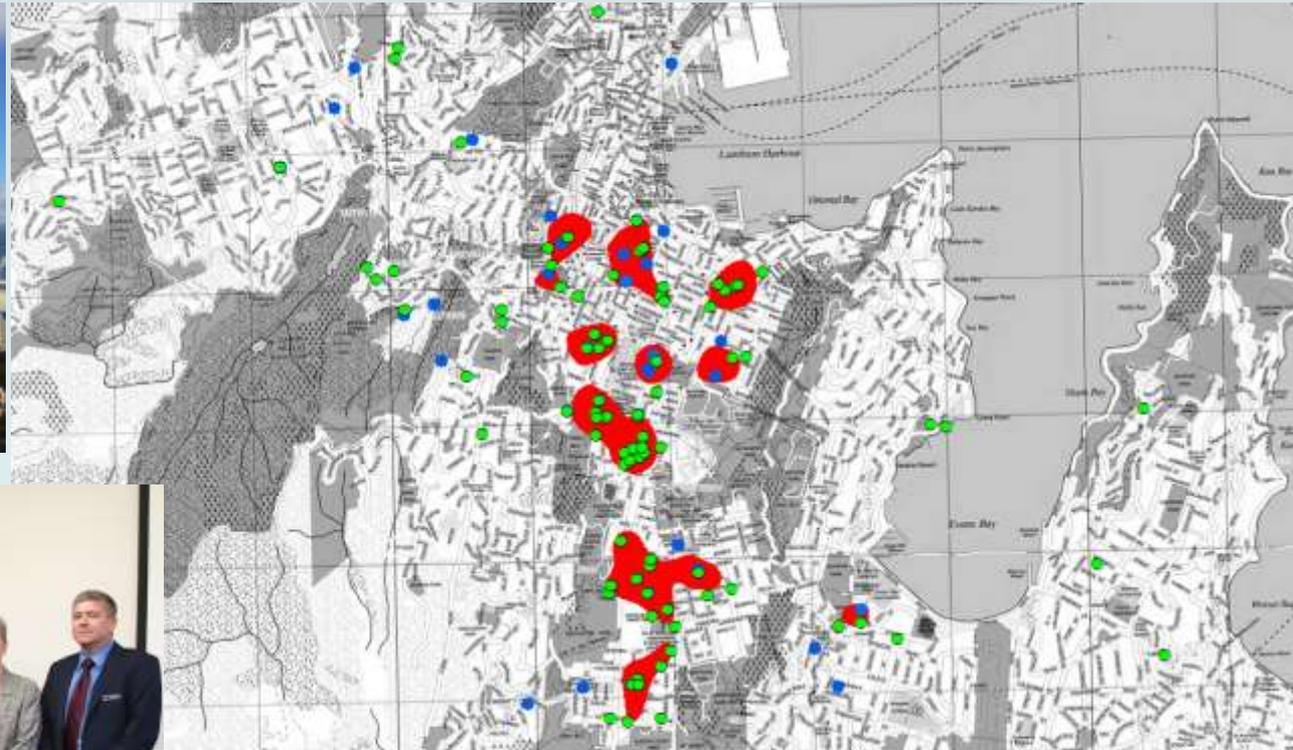
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# From tackling street drinking in Wolverhampton (UK) ...



# ... to predicting crime in Wellington (New Zealand)



**New Zealand Problem-Oriented Policing award winners 2014 – Christchurch Police District**

**Analysis forums identified upto 45% of burglary could be predicted. Prevention Managers Masterclasses focused on how it could be prevented**

# From hotspot policing (Rhyl, Wales) to pacification (Rio, Brazil) ...



# Outline

- The role of analysis in policing
  - Contemporary policing: intelligence-led policing, problem-oriented policing, and evidence-based policing
  - The analytical function
- The Crime Prediction Framework
  - The *future*: immediate, near and distant
  - Aligning predictions to service responses
  - Data and analysis techniques for predicting crime must be sensitive to the spatial-temporal patterns of crime
- Introduce a methodical framework for predicting crime and how this should then inform how you go about responding to crime
  - Emphasising the value of an analytical approach

# What is intelligence-led policing?

- Using intelligence to inform police decision-making
  - Rather than a purely responsive police strategy
    - Example: tackling problem of repeat offenders (using intelligence) rather than *responding* to offenders
- Systematic analysis (intelligence products) to identify patterns
  - People: offenders and victims
  - Places: locations, buildings, facilities
- Involves information sharing and collaborative work with partner agencies



# The UK intelligence production process

## 12 month intelligence development cycle

### Plan/Control Strategy

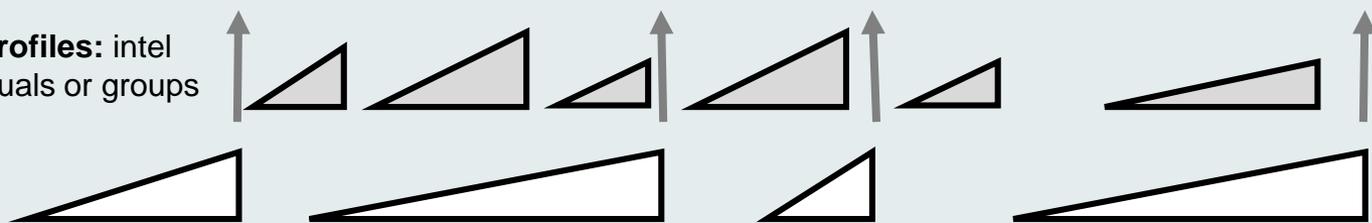
Strategic Assessment

Action against strategic priorities with new issues being considered if escalated from Tactical Assessments

Strategic Assessment

**Tactical Assessments:** monitoring performance, identifying emerging issues, tasking/co-ordinating actions

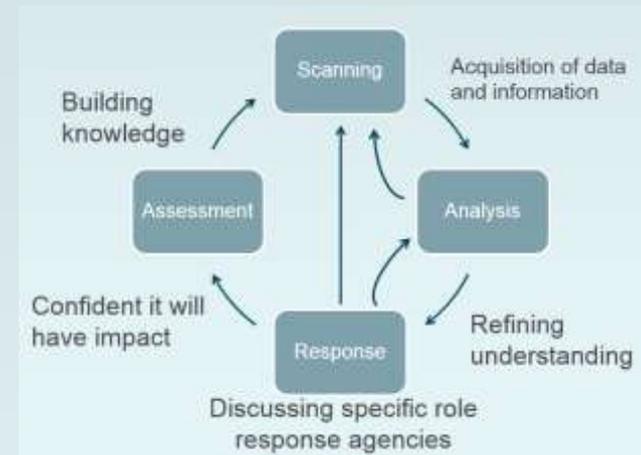
**Target Profiles:** intel on individuals or groups



**Problem Profiles:** analysis that adds new intel by understanding and explaining the problems it considers

# What is problem-oriented policing?

- Understanding the problem, dealing with its causes, rather than just reacting to individual events
- Being *crime specific* – breaking the problem apart
- Influencing decision-making with good analysis
- Recognising the importance of the immediate situation, temptations and opportunities in determining offending behaviour and vulnerability
- Thinking through how a given response will work
  - Measuring response impact



# Problem-oriented policing

Tackling alcohol related violence in Cardiff

# What is evidence-based policing?

- To determine *what works*
  - **Generate evidence:** conduct empirical research that involves robust evaluations of police activity
  - **Use evidence:** use of robust scientific evidence on the outcomes of police work to guide police activity

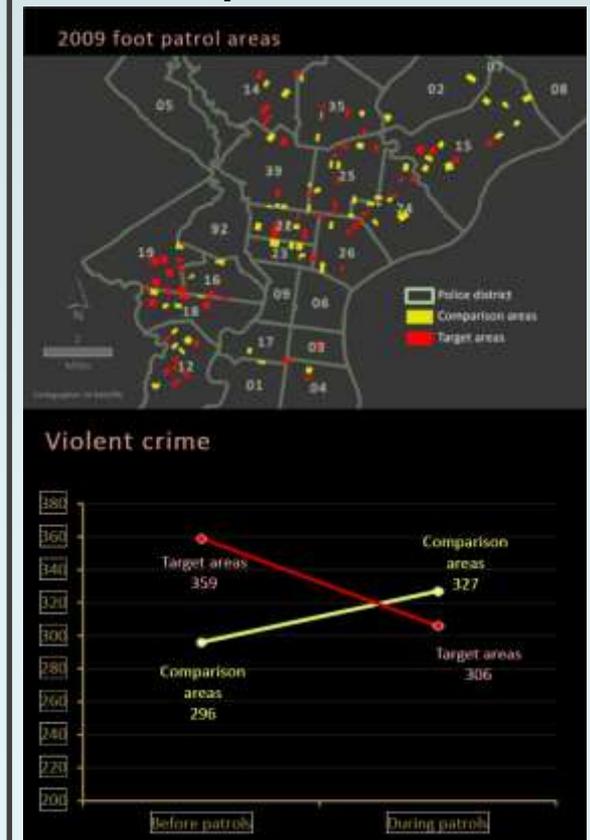
Specific crime problems (e.g., burglary)

Improving practices (e.g., hotspot policing)

Improving programmes (e.g., Neighbourhood Watch)

Improving policies (e.g., offender rehabilitation)

## Philadelphia Foot Patrol Experiment



Targeted foot patrols reduced violent crime by 23%

# Evidence-based policing ...

But to apply *what works*, need to know:

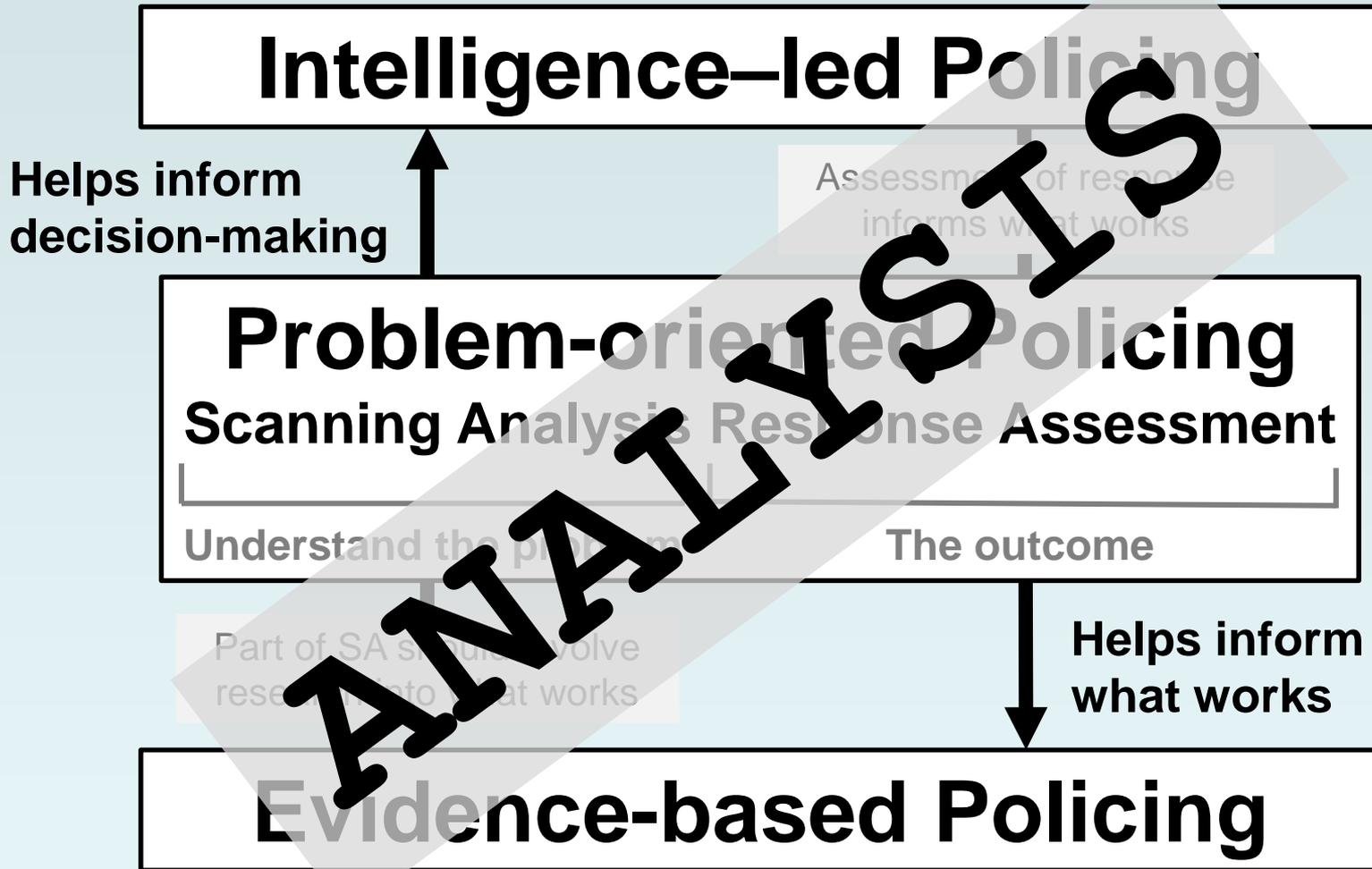
1. How it works (conceived, implemented, and sustained)
  - Sheds light on why it worked for them, and may not work for you!
2. What's our problem?
  - Understand your problem (i.e., good analysis)
    - Translate 'what works' to your context
    - Understand what is likely to work (particularly if there is limited evidence-base)

## Philadelphia Foot Patrol Experiment



- Patrols: 5 days a week, 16 hours per day, over 22 weeks, 15-20 mins per hour spent in hotspots during problem
- Officer boredom (standing still, not much to do ...)
- Violence returned to previous levels within 3 months

# The relationship between ILP, EBP, and POP



## The role of analysis ... (1 of 3)

- **What is going on? What is likely to happen in the future?** Involves a set of systematic processes that aim to identify and interpret patterns and correlations between crime data and other relevant information sources
- **What can we do to tackle it?** For the purpose of supporting decision-making that informs and prioritises the design and allocation of police activity and crime prevention responses

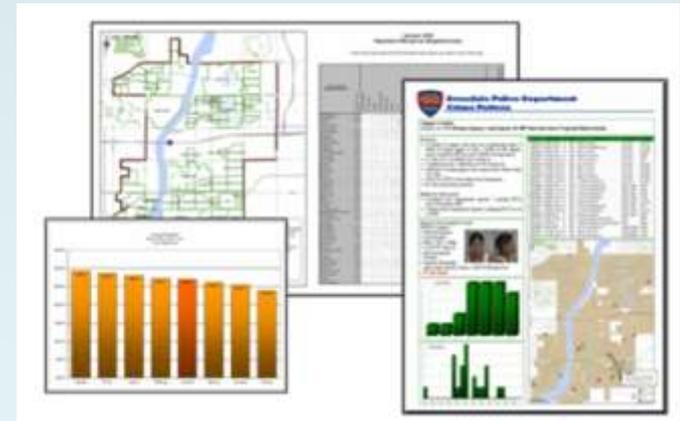
## The role of analysis ... (2 of 3)

Also ...

- Supporting the **best use of limited resources** available for tackling crime and improving public safety
- Providing an **objective** means of identifying and understanding crime problems
- Taking advantage of the volumes of **information** that are collected by the police and other agencies

## The role of analysis ... (3 of 3)

- Crime analysis endeavours to provide the *“right information ... to the right people at the right time”* (Fletcher, 2000)
- *“Analysts should not simply provide management with statistics and colourful charts but a real understanding of criminal activity and the direction in tackling it”* UK Criminal Intelligence Strategy Group



Fletcher, R. (2000). An intelligent use of intelligence: Developing locally responsive information systems in the post-Macpherson era. In A. Marlow and B. Loveday, eds., *After Macpherson: Policing After the Stephen Lawrence Inquiry*. Russell House Publishing, Dorset.

# The role of the analyst

Each role overlaps and complements the others

- Reviewing performance and outcomes
  - Performance reports, evaluations
  - Live performance meeting e.g. CompStat
- Informing operational police tactics
  - E.g. targeting of police patrols
- Informing crime prevention initiatives
  - E.g. Problem solving analysis
- Supporting an investigation
  - E.g. serial crime investigation, cell phone analysis
- Products and techniques: target profile analysis, problem profile, network analysis (i.e. offender associations) ...



# Reviewing performance/directing new actions

Transport for London/British Transport Police CompStat – the analysts role

Pause



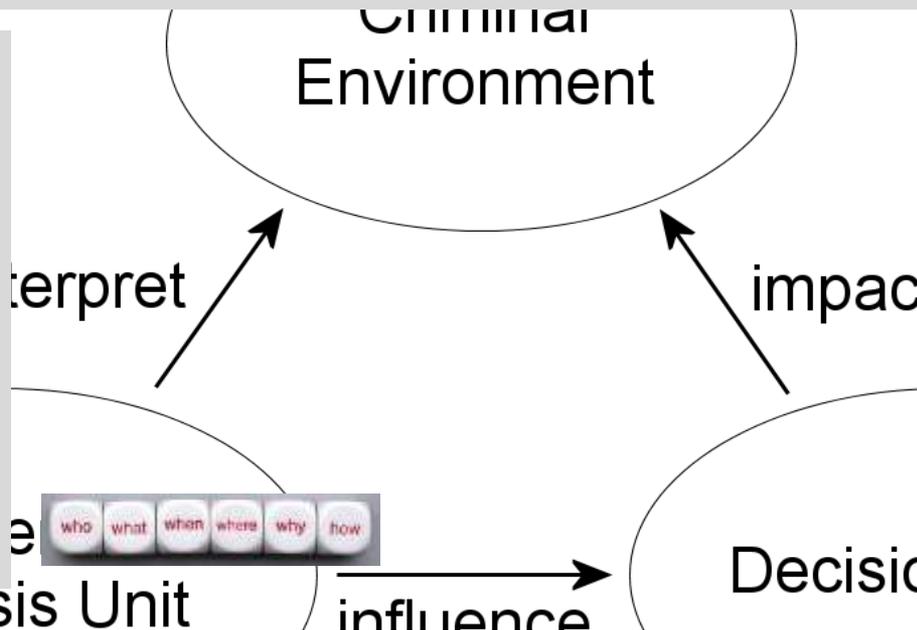
# The role of analysis

Hotspot policing, Operation Ceasefire (tackling gangs), CCTV, Neighbourhood Watch, Scared Straight, CPTED (crime prevention through environmental design), restorative justice, and predictive policing all types of interventions and strategies

## Intelligence:

Analysis of information:

- crime records
- calls for service
- patrols (incl stop/search)
- covert surveillance
- offender interviews
- informants
- site visits
- public engagement
- socio-demo data
- partner data ...



## Response opportunities:

- Investigation/detection
- Deterrence
- Disruption and diversion
- Treatment and support
- Victimization/risk/harm reduction
- Reassurance
- Public confidence
- Community engagement

**Intelligence product:** fundamental component to intel-led policing, facilitating decision-making framework

# Good policing and effective crime reduction

Involves three types of service response ...

1. Immediate, operational response: for example, targeting of police resources on the next patrol shift



# Good policing and effective crime reduction

## Involves three types of service response ...

2. Medium-term, situational response: for example, working with other local agencies to address opportunities for committing crime

### Tackling violent crime associated with night-time economy in Northampton

**PATROL POINTS**

Point 1 (Leeds) and Point 2 (Theatre) are hotspots for violent crime. High volume of incidents in the area.

Point 3 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 4 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 5 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 6 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 7 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 8 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 9 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 10 (Theatre) is a hotspot for violent crime. High volume of incidents in the area.

Point 11 (Leeds) is a hotspot for violent crime. High volume of incidents in the area.

Point 12 (Club Row) is a hotspot for violent crime. High volume of incidents in the area.

Point 13 (Albion) is a hotspot for violent crime. High volume of incidents in the area.

Point 14 (Flyways) is a hotspot for violent crime. High volume of incidents in the area.



### Reducing motorbike theft in London



# Good policing and effective crime reduction

Involves three types of service response ...

3. Long-term, strategic response: for example, addressing endemic causes through regeneration schemes and changes in policy



**Before: chaotic, insecure storage, high theft**

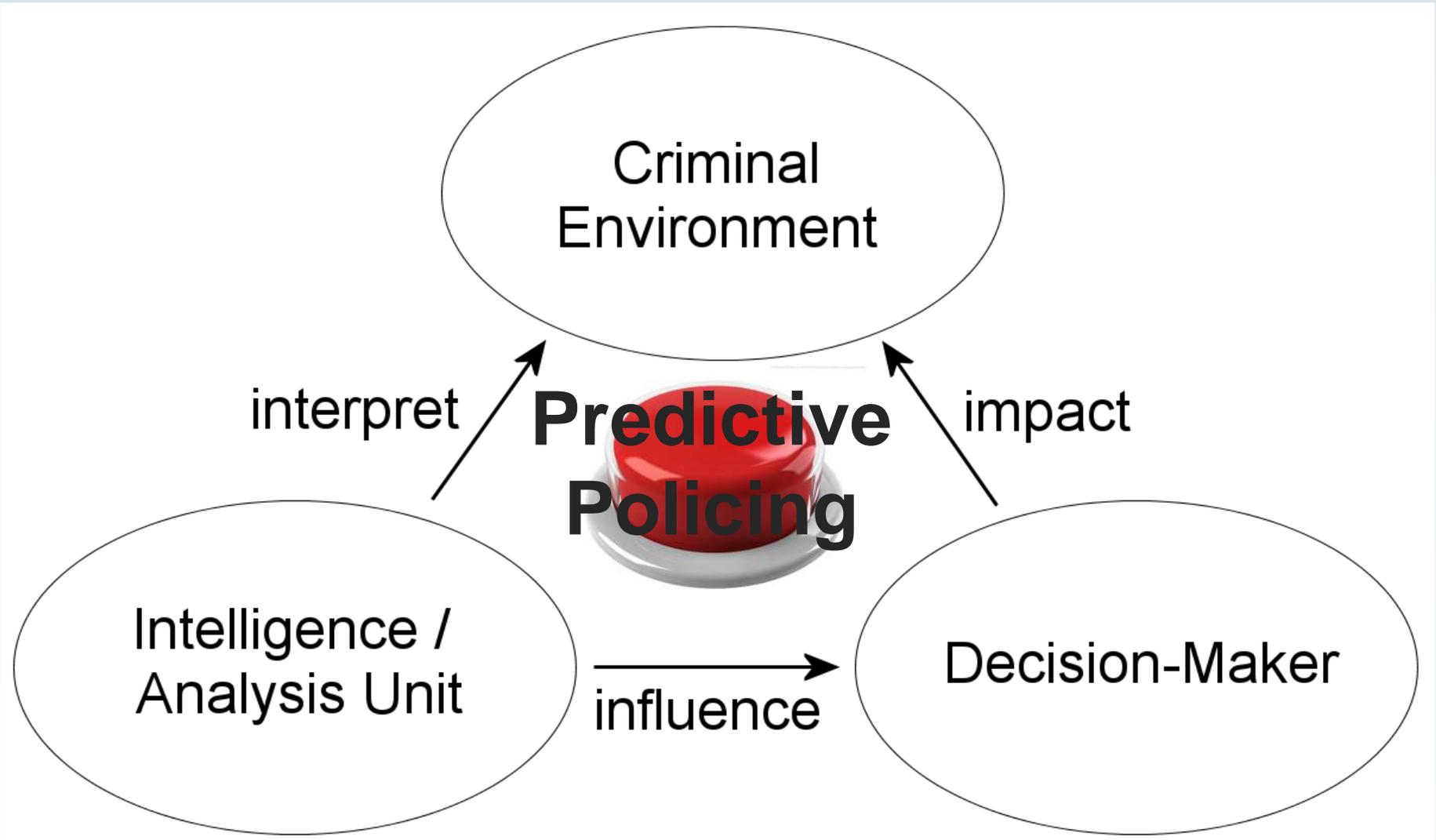
**Marylebone Station**



**After: organised storage, more secure, low theft**

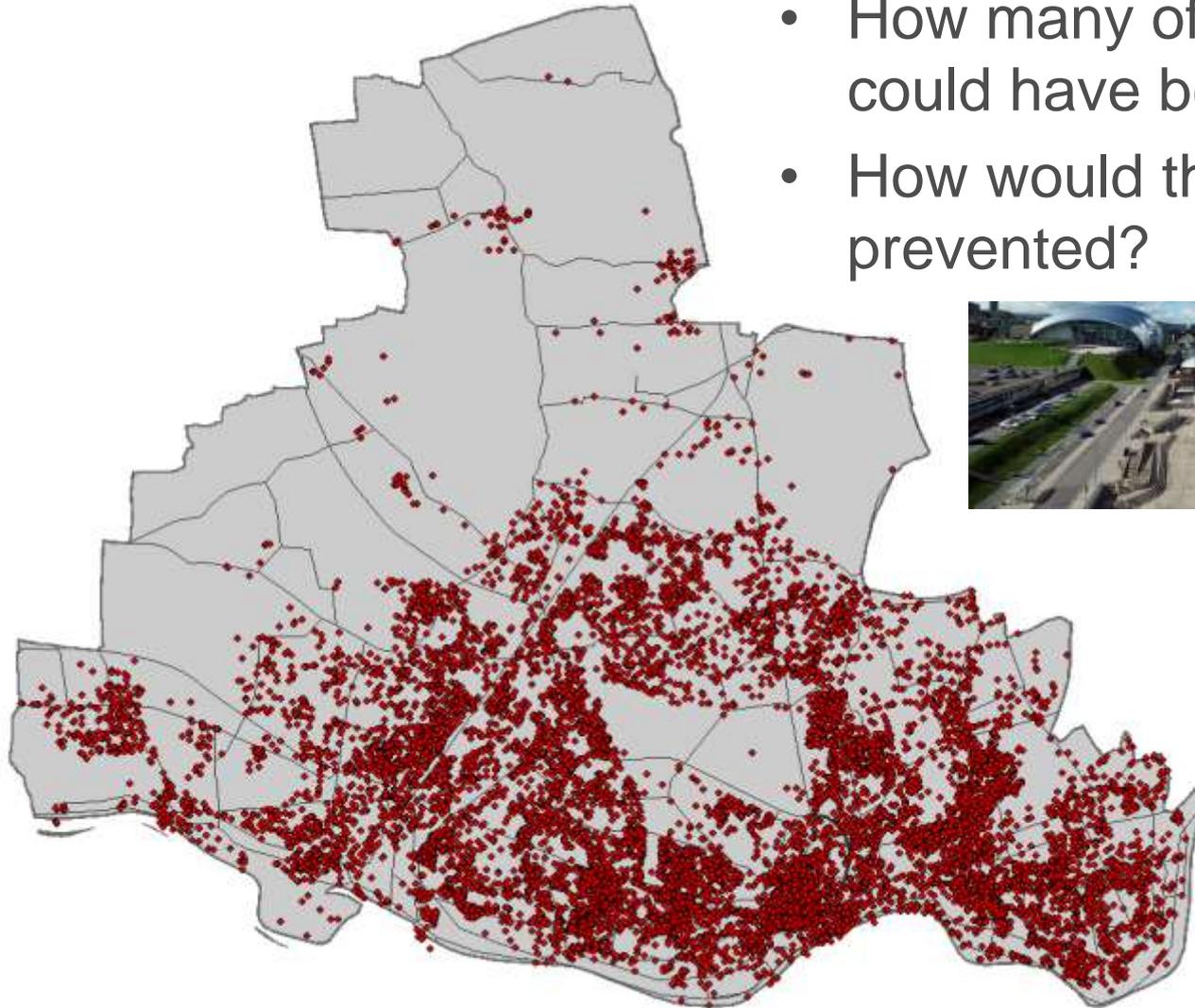


# Predictive policing is not a short cut for good policing and effective crime reduction



## A year of crime in Newcastle (October 2013 to September 2014, $n = 24,259$ )

- How many of these crimes could have been predicted?
- How would they have been prevented?



## A day of crime in Newcastle, England (1 October 2013) (n = 85)

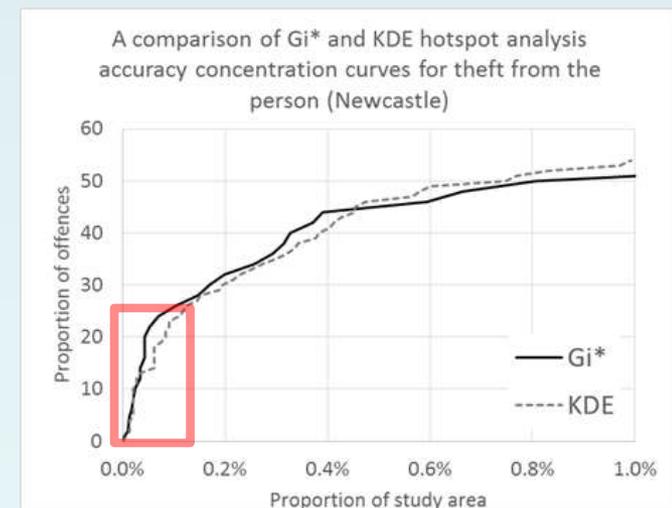
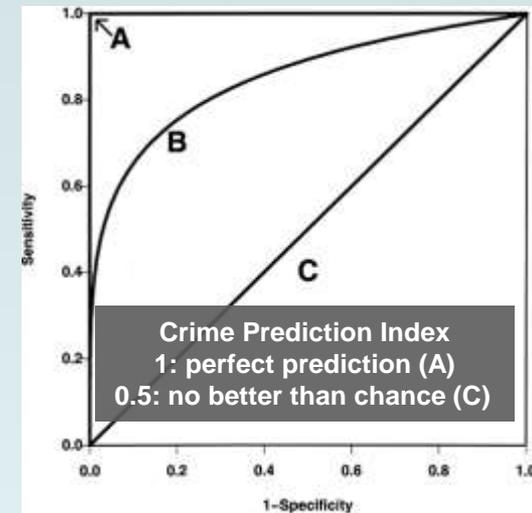
- How many of these crimes could have been predicted?
- How would they have been prevented?



# Spatial crime prediction – the research

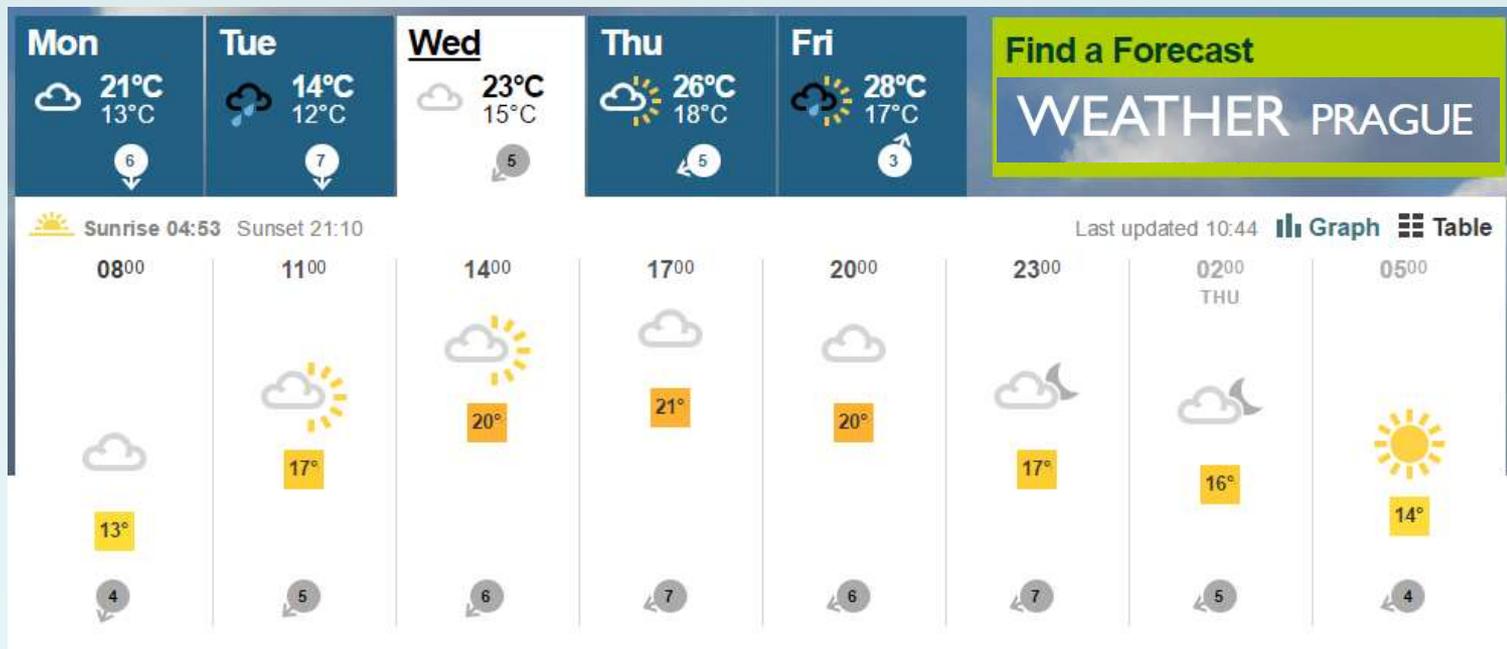
## Seven year research study into spatial prediction of crime

- Rigorous statistical methods for measuring prediction performance
  - Accuracy concentration curves (ROC curves)
  - Crime Prediction Index (area under the curve)
- Prediction performance of hotspot analysis techniques
  - Spatial ellipses, choropleth mapping, kernel density estimation and the  $G_i^*$  statistic
- Temporal stability of hotspots
- Extent to which recent crime informs future crime
- Extent to which spatial regression analysis can inform predictions of crime
- Within the context of 20 years of practical experience of policing and public safety



# An analogy: weather forecasting

- Forecasting the next few days
  - Data: recent weather best predictor of the immediate future
  - Forecasting technique that draws on current known patterns of weather e.g., movement of weather fronts, rainfall radar, movement of high pressure systems



# An analogy: weather forecasting

- Forecasting the next week/month
  - Data: recent and seasonal trends
  - Forecasting technique: models that combine recent weather patterns with upper atmosphere weather movements, and seasonal patterns



**Monthly Outlook**

**Summary**

**Summer and wind trends**

We're a week into the meteorological summer and it's been a bit of a roller coaster for us. We started the season on a windy note with severe weather warnings issued for most of the country before things slowly calmed down during the week. High pressure became established over the southern half of the UK bringing warmer, lighter winds and the warmest day of the year so far at Cranbury, Kent where we saw 26°C. The northern half of the UK has had a very different week with strong winds, heavy showers and occasional large spells of sun sounding around the top of the high bringing temperatures back to below average.

Will the pattern continue or are there changes on the way? Read on to find out.

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**Monday 8 June—Sunday 14 June**

**Mainly dry and sunny... for now!**

We start the week with high pressure in charge of the weather across the UK. There will be a few showers around on Monday but at any point Northern Ireland but aside from those it's a dry start to the week. There will be lots of blue skies and light winds so expect lovely nights, perhaps with a touch of grass frost, and pleasantly sunny days. Large overnight savings of temperatures may mean you need to look a leg to get your jumper to wear if you're heading out early, or have an extra layer if you're going out for an evening.

By Wednesday the high pressure will start to look a bit grumpy on the weather pattern. Strong winds will blanket the country, weakly in the north, heaviest in the south. Despite this, Wednesday looks like the warmest day of the week for many.

As the high pressure continues to break down, a band of rain will move west from the north through Thursday as an area of heavy showers and perhaps thunder rain moves up from the south. Cooler conditions will start to spread in from the northwest with the sunless drizzle set to warm temperatures for a final day. There is low confidence about how these two features will interact come Friday but most parts will see at least some sun for a time.

Into the weekend the battle between high and low pressure continues with the most settled weather being found across the north and east with a bit of further heavy showers across the south and west. There will be good dry and sunny spells across the board though. Temperatures may finally be near to the weather average.

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**Monday 25 June—Sunday 31 June**

**Something for everyone, including the doctor!**

Following on from a very interesting weather, this week looks like bringing more of the same. It's likely but surely the weather will start to become more unsettled from the northwest and the high pressure finally weakens and allows showers and bigger spells of sun to push into the UK. This is likely to bring more than average temperatures through the afternoon between day and night and not be as stark as the previous week. Higher temperatures will bring in the south-east longer into the week but this, coupled with higher humidity, may lead to the odd Thursday outbreak here.

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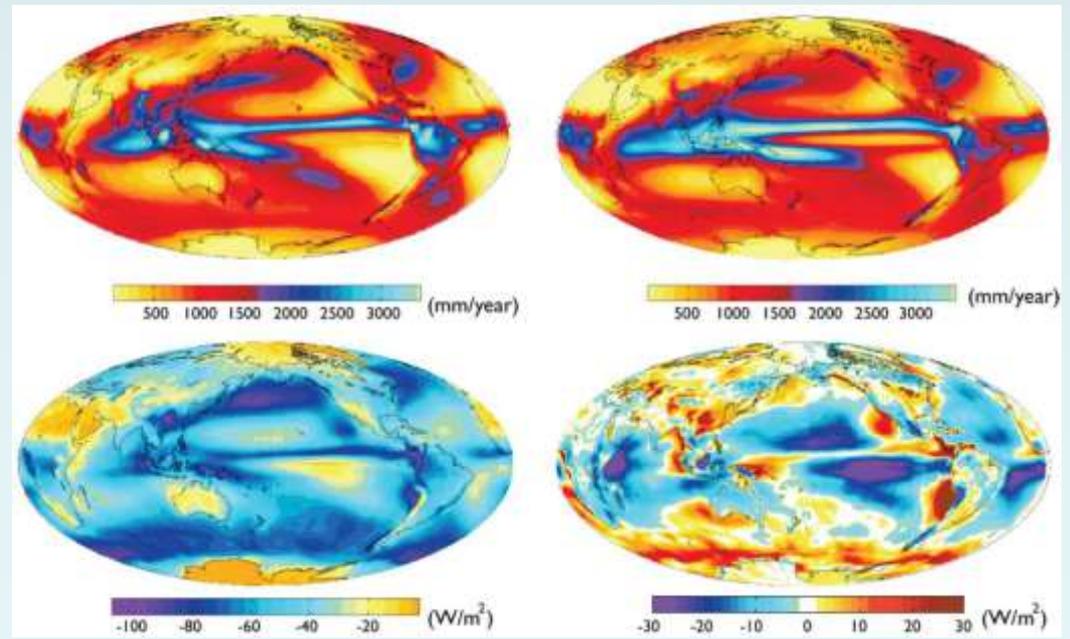
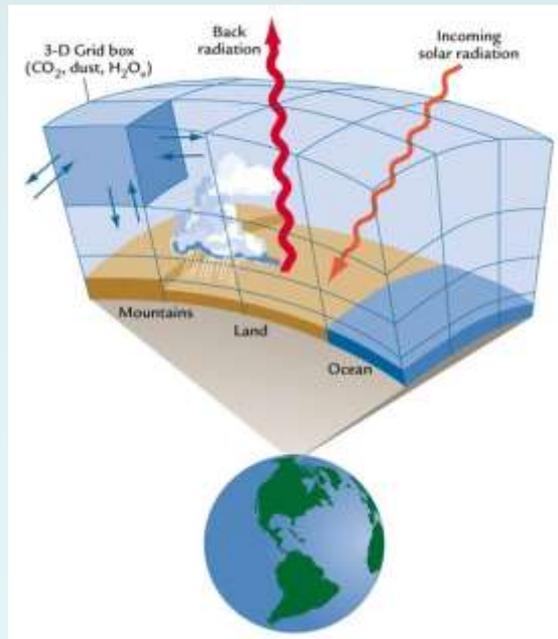
**Monday 22 June—Sunday 5 July**

**It's very British weather**

Towards the end of June and into the start of July it looks as though we're going to see an area of high pressure moving towards the UK from the Azores but struggling against the wind. Unsettled weather pattern at the present time. With this means in terms of the weather we can expect a bit of a north-south divide! In the north and west the weather is likely to be unsettled with showers and longer spells of sun and strong winds at times too. Temperatures are looking like being below average too. In the south and east the weather will be more settled with longer sunny periods and lighter winds but still being windy by night. All parts will see at least some sun or at least showers, but the focus for this type of weather will be northern and western Scotland, northern Ireland and northern England. The best of the dry and bright weather will be found in eastern and southern Scotland, Wales and western and southern England with the highest temperatures likely in the south-east of England.

# An analogy: weather forecasting

- Forecasting the next few years
  - Data: climate trends, cyclical events (e.g., El Nino), sea temperature, greenhouse gases
  - Forecasting technique: models that examine the relationship between variables that influence changes in climate



# Predictive mapping techniques and data

- Shows where ... but weaker in informing when, and why, and what to do when there?
- **Data:** little consideration given to different influence that different data has on predicting crime
- **Interpretation - explaining why:** if spatial predictions of crime are to be made with confidence, the prediction must be based on clear theoretical principles
  - Which in turn informs the type of responseAnalysis provides the interpretation  
Computer generated output only offers description
- **The future:** lack of consideration given to what is meant by *the future* – the next few hours, days, weeks ...?

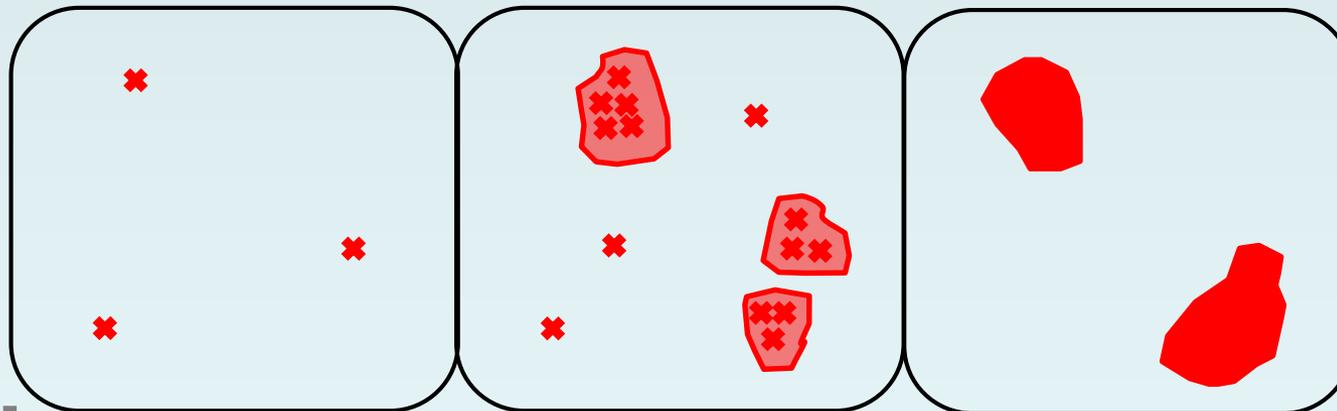
# Predictions aligned to service responses



**Police/Law Enforcement**

**Crime prevention initiatives**

**Strategies and changes in policy**



**Now**

**Immediate**

**Near**

**Distant**

**Future**

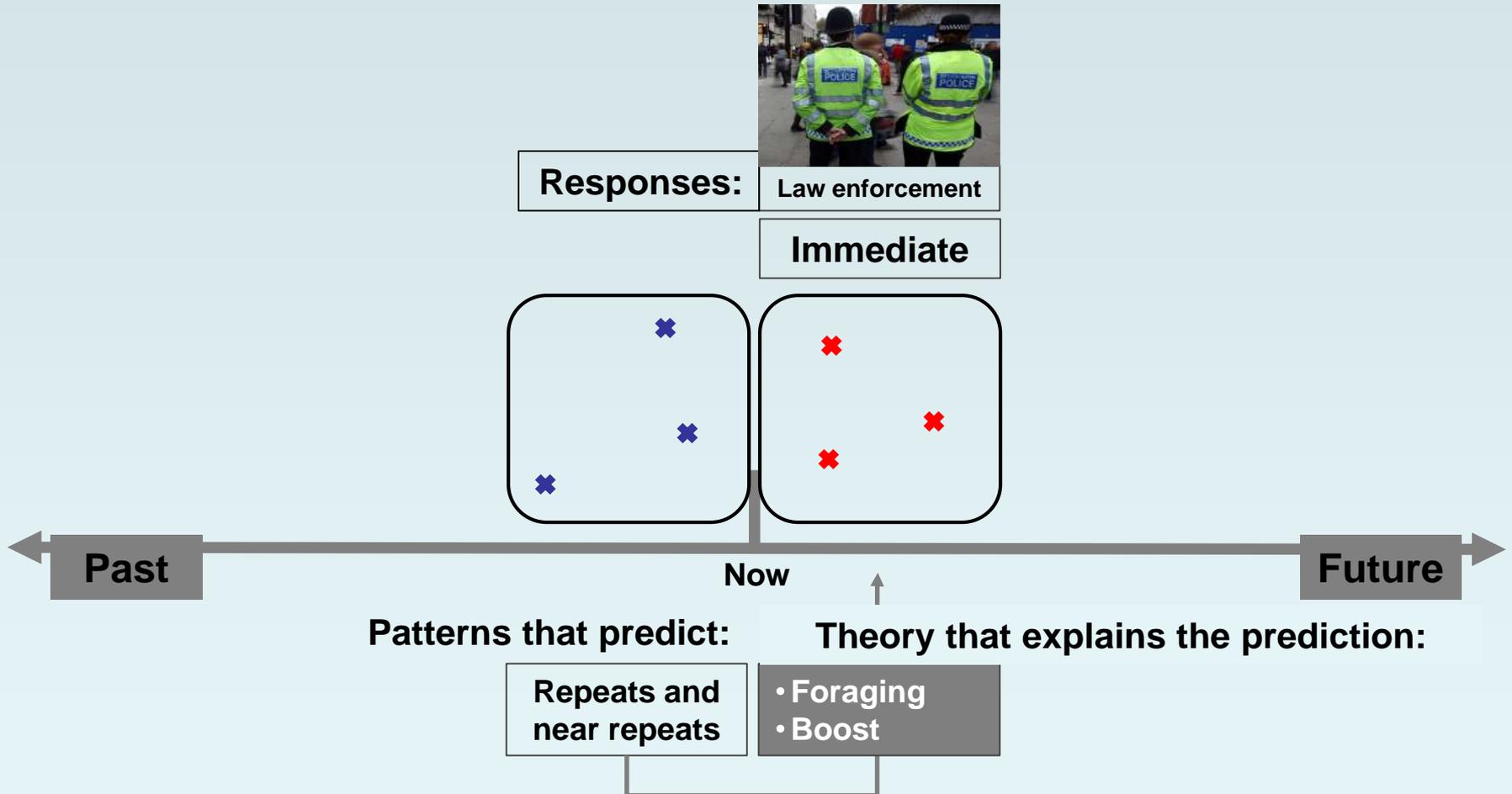
**Appear random**

**Hotspots**

**Persistent hotspots**

# Predicting the immediate future

## The Crime Prediction Framework



# Predicting the immediate future

## Identifying immediate risk using repeat and near repeat patterns

- Repeat victimisation:
  - Heightened risk (and temporal decay of this risk) after an initial victimisation
  - **Newcastle (UK): 15% of all burglaries (2010)**
  - **South Auckland (NZ) 10% of all burglaries (2014)**
- Near repeat victimisation:
  - Heightened risk within short space/time of *originator* incident
  - Within 7 days and 200m of originator incident:*
  - **Newcastle: 23% of all burglaries (2010)**
  - **South Auckland: 15% of all burglaries (2014)**



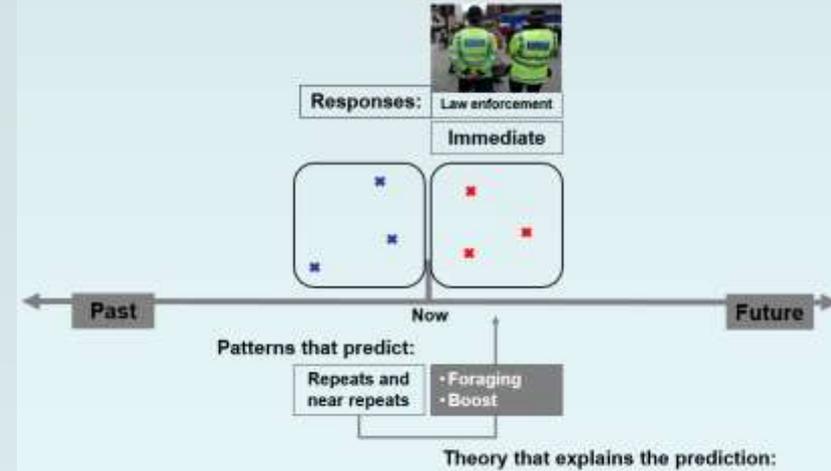
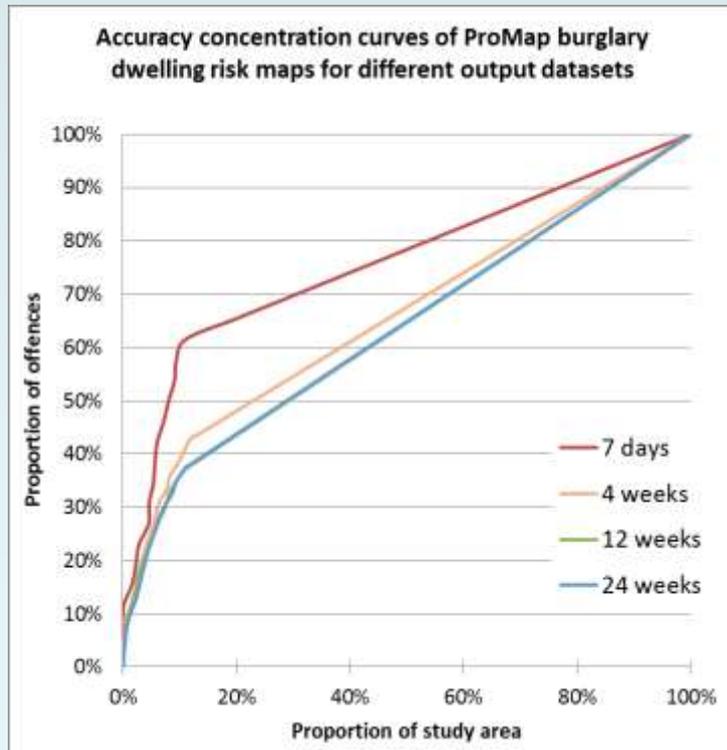
# Immediate future

Patterns that predict: repeats and near repeats

## Prediction accuracy

### Accuracy concentration curve

(the more vertical the curve the better the prediction)



## Crime Prediction Index

(1 is a perfect prediction)

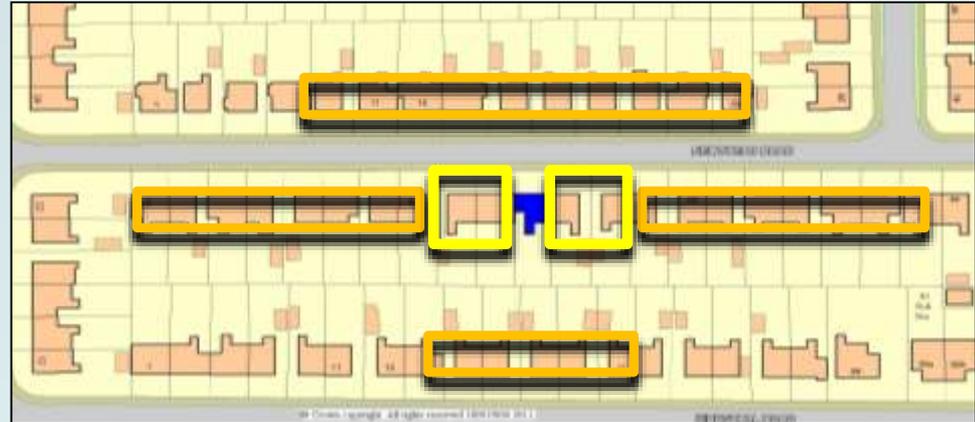
<i>Future period</i>	<b>Domestic burglary</b>	<b>Theft from person</b>	<b>Violent assaults</b>
<b>7 days</b>	<b>0.772</b>	<b>0.993</b>	<b>0.943</b>
<b>4 weeks</b>	0.635	0.992	0.887
<b>12 weeks</b>	0.608	0.938	0.838
<b>24 weeks</b>	0.553	0.901	0.834

- RV and NRV patterns most accurate for predicting immediate future
- Additional data can harm accuracy of the prediction

# Police responses for predicting the immediate future

(Source: Chainey, 2012; Fielding and Jones, 2012)

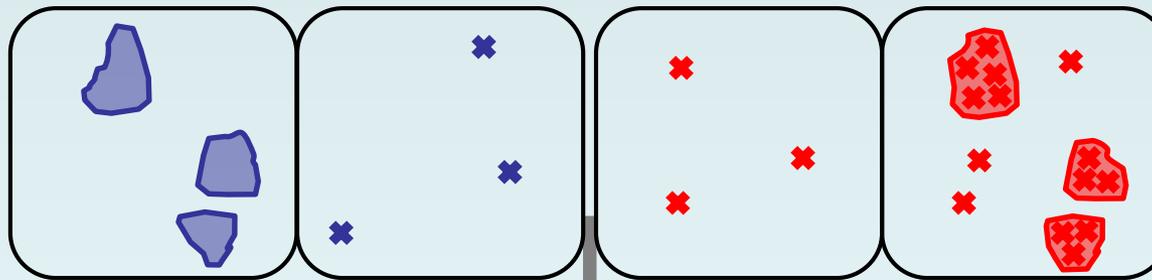
- Countering the predicted heightened risk
  - Crime prevention officer
    - Visits burgled properties within 24 hours
  - Neighbourhood Police:
    - Visit neighbouring properties; as much face-to-face contact with residents as possible: Inform – Reassure – Advise
  - Visits (in high visibility uniform) to coincide with times when there have been burglaries
- Detection opportunities
  - Same offender; stop and search; prolific offender supervision; targeted forensic opportunities



# Predicting the near future

## The Crime Prediction Framework

Responses:



Past

Now

Future

Patterns that predict:

Theory that explains the prediction:

Hotspot analysis

Repeats and near repeats

- Foraging
- Boost

- Generators/ attractors
- Flag



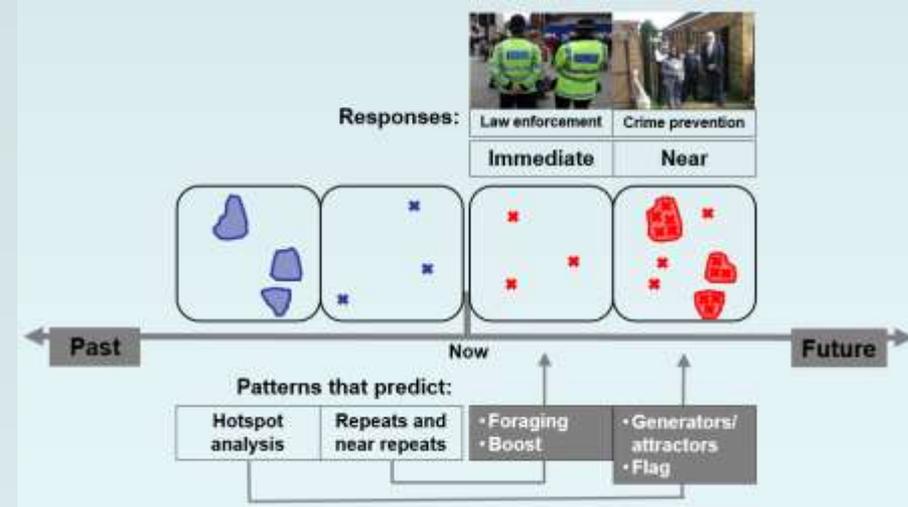
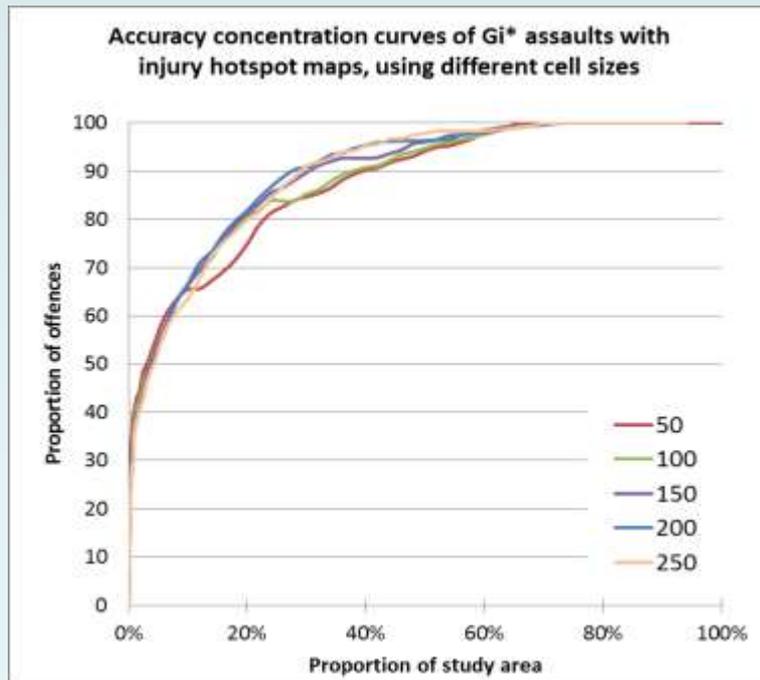
# Near future

Patterns that predict: hotspot analysis

## Prediction accuracy

### Accuracy concentration curve

(the more vertical the curve the better the prediction)



## Crime Prediction Index

(1 is a perfect prediction)

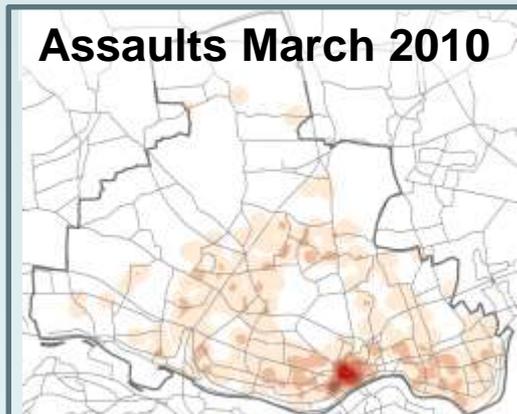
Crime type	CPI $G_i^*$ 95% significant
Burglary dwelling	0.960
Theft from the person	0.997
Assault with injury	0.995

E.g., based on 3 months of crime data to predict crime in next month

**Hotspots most accurate at predicting the near future ( $G_i^*$  better than KDE)**

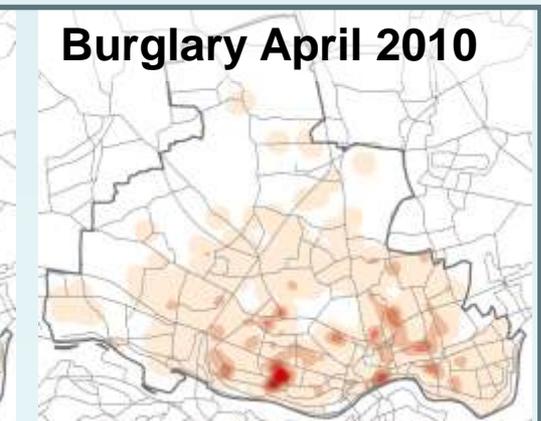
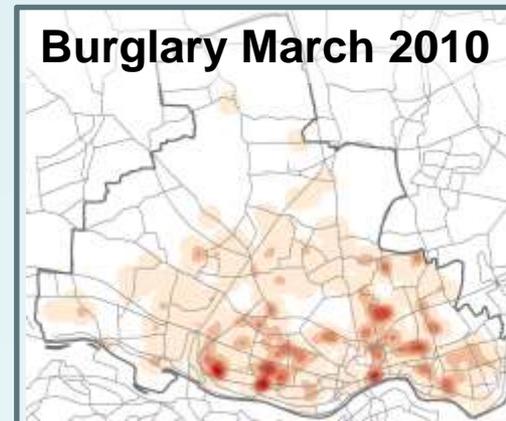
# Predicting the near future

- Where crime concentrates one month
  - Likely to concentrate in same location the next month!



## Example: Newcastle, England

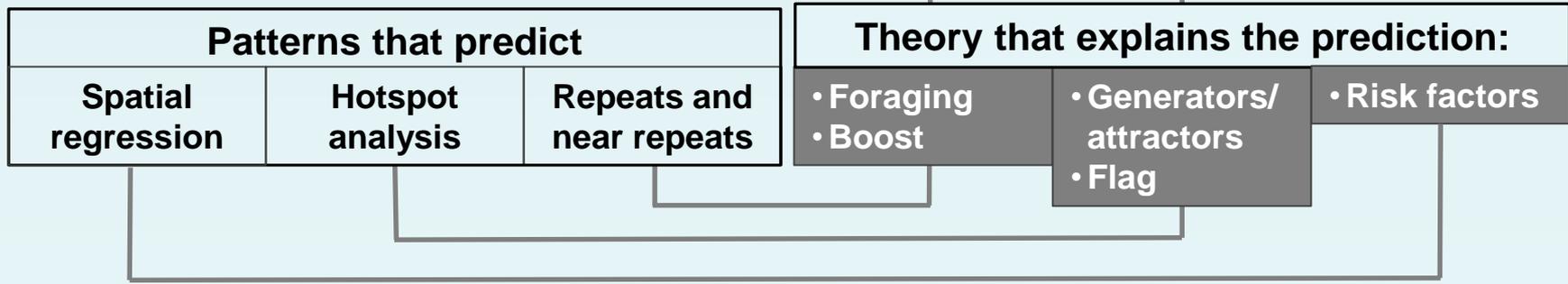
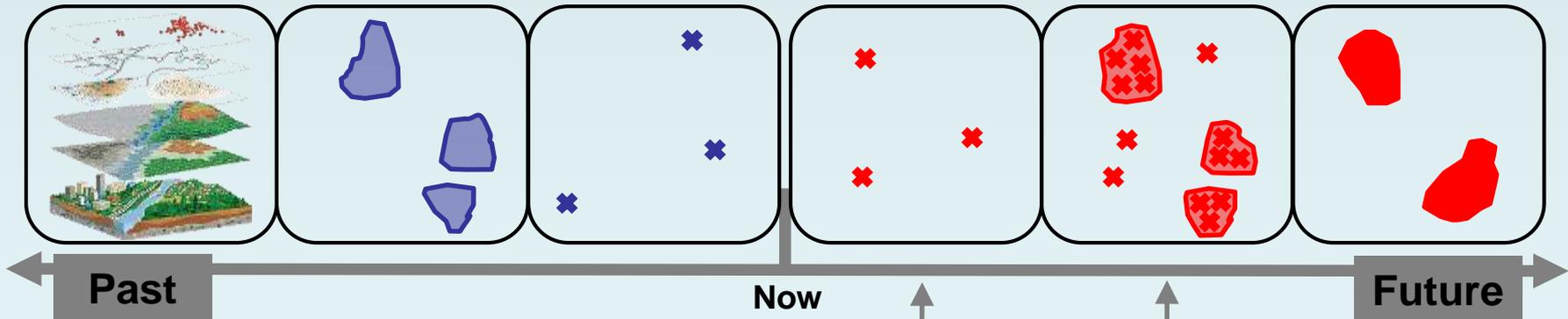
Crime type	Crimes committed in April 2010	Number of crimes in hotspots	Percentage of crimes in hotspots
Burglary dwelling	130	21	16%
Theft from the person	60	41	68%
Theft from vehicle	190	48	25%
Assault with injury	154	68	44%



# Predicting the distant future

## The Crime Prediction Framework

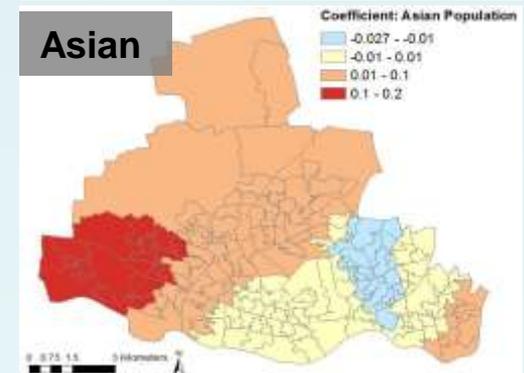
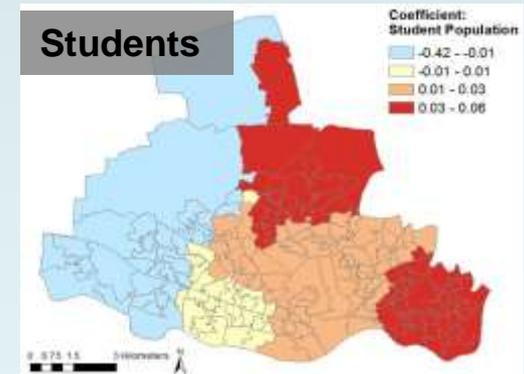
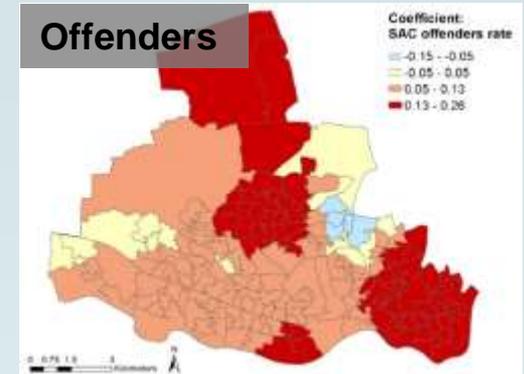
Responses:



# Distant future

## Patterns that predict: spatial regression

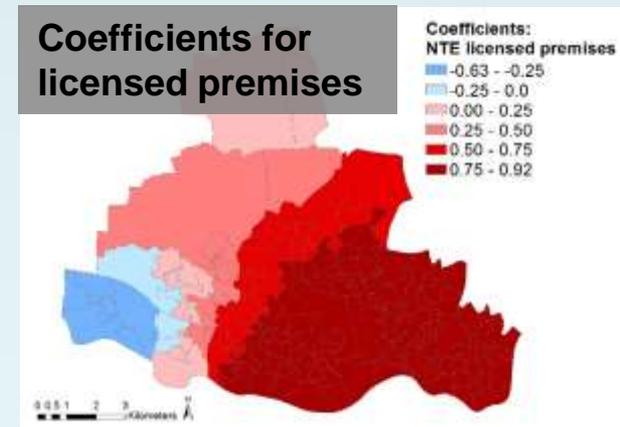
- Identifying those variables that are statistically related to distribution of crime
  - Geographically Weighted Regression – identifies spatially varying relationships
- Coefficients can be used to help *predict* how change in explanatory variable is likely to influence change in crime
- Example: domestic burglary in Newcastle, UK
  - Significant variables: burglary offenders, student population, Asian population



# Distant future

## Patterns that predict: spatial regression

- Identifying those variables that are statistically related to distribution of crime
  - Geographically Weighted Regression – identifies spatially varying relationships
- Coefficients can be used to help *predict* how change in explanatory variable is likely to influence change in crime
- Example: domestic burglary in Newcastle, UK
  - Significant variables: burglary offenders, student population, Asian population
- Example: violent assaults in Newcastle, UK
  - City centre: 10% increase in licensed premises could yield 9% increase in assaults (or vice-versa)





# Conclusions

- The bedrock of all types of contemporary policing is analysis
- Prediction is not only about where and when ...
  - Need to explain **why** so you can determine what to do to counter the predicted activity (i.e., analysis is about understanding **why**)
- Policing is not only about tackling the immediate future
  - Policing approach that purely orients itself to the immediate future will undermine ability to shift/share responsibility to other agencies
  - Will undermine approaches for sustainably reducing crime
- Effective policing and crime prevention is based on good analysis
  - A push button approach to prediction will undermine the necessity for analysis
  - Analysis is required to effectively interpret crime problems, and influence decision-making on the responses to implement that have an impact on crime and improving public safety

# Responding to and prevention crime?



or



# Responding to and prevention illness?



**or**



# Thank you

The Jill Dando Institute of Security and Crime Science  
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