
Human Use and Discharge

Prof David W Graham

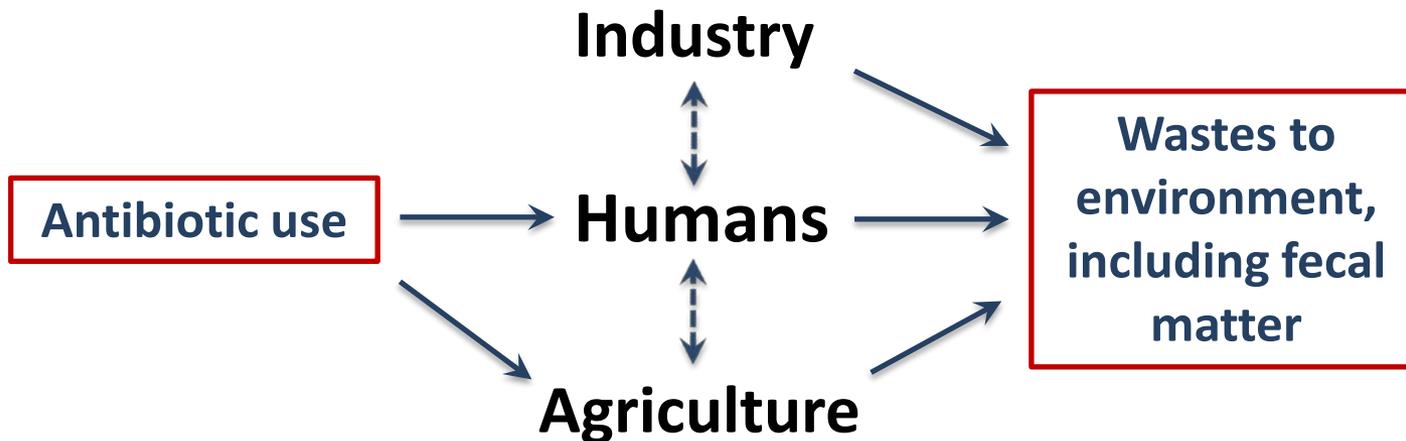
**Newcastle University
Newcastle upon Tyne, United Kingdom**

**June 22, 2016 PACCARB Public Meeting
Hubert H. Humphrey Building, Washington, DC**



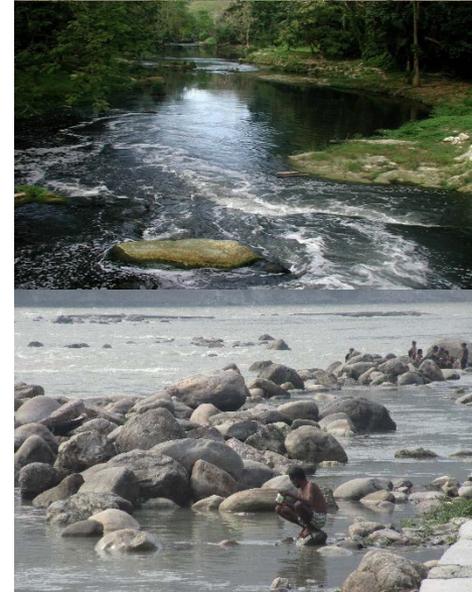
Drivers of AR

- “Antibiotic resistance (AR)” = Mutations or acquisition of genes that reduce/eliminate the effectiveness of antibiotics



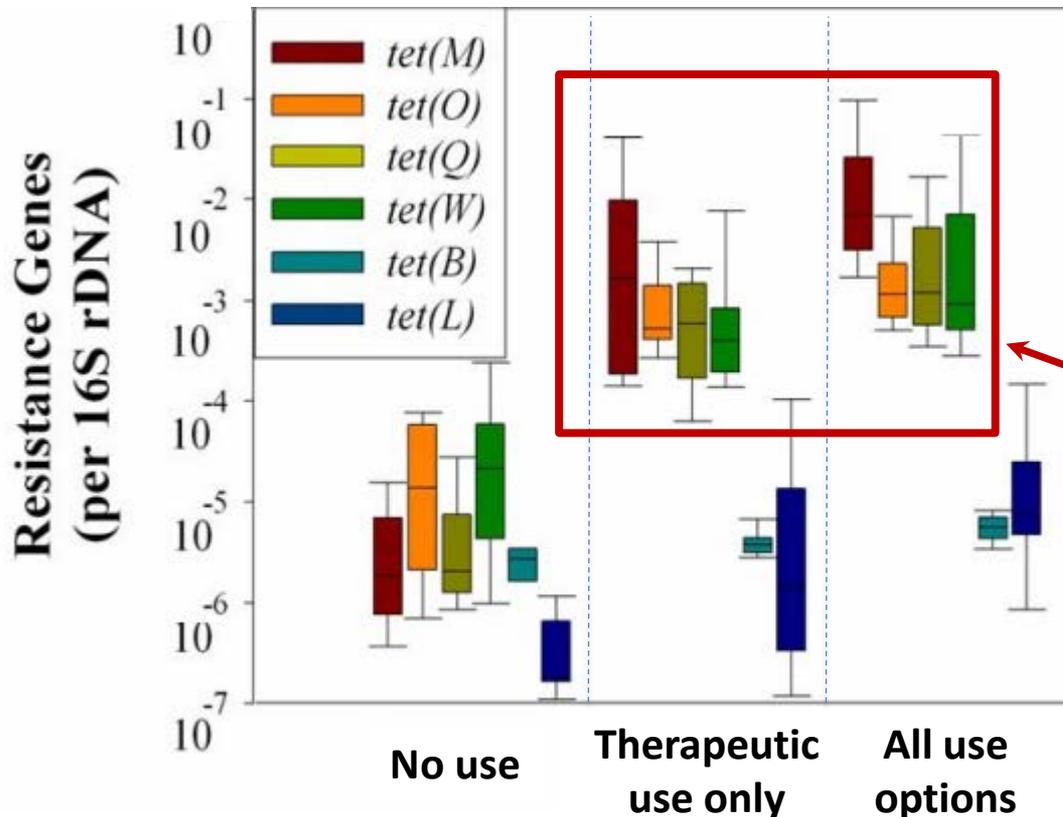
- “One-Health” assumes human, animal and ecosystem health are interconnected, and health solutions must cross the interfaces

Graham *et al.* 2016. Appearance of β -lactam resistance genes in agricultural soils and clinical isolates over the 20th Century. *Sci. Rep.* 6:2016



Antibiotic use, wastes and waterborne AR

- Large animal feedlot lagoons = An analogue for human discharges/exposures without local waste treatment



- 27 feedlot lagoons in KS and NE

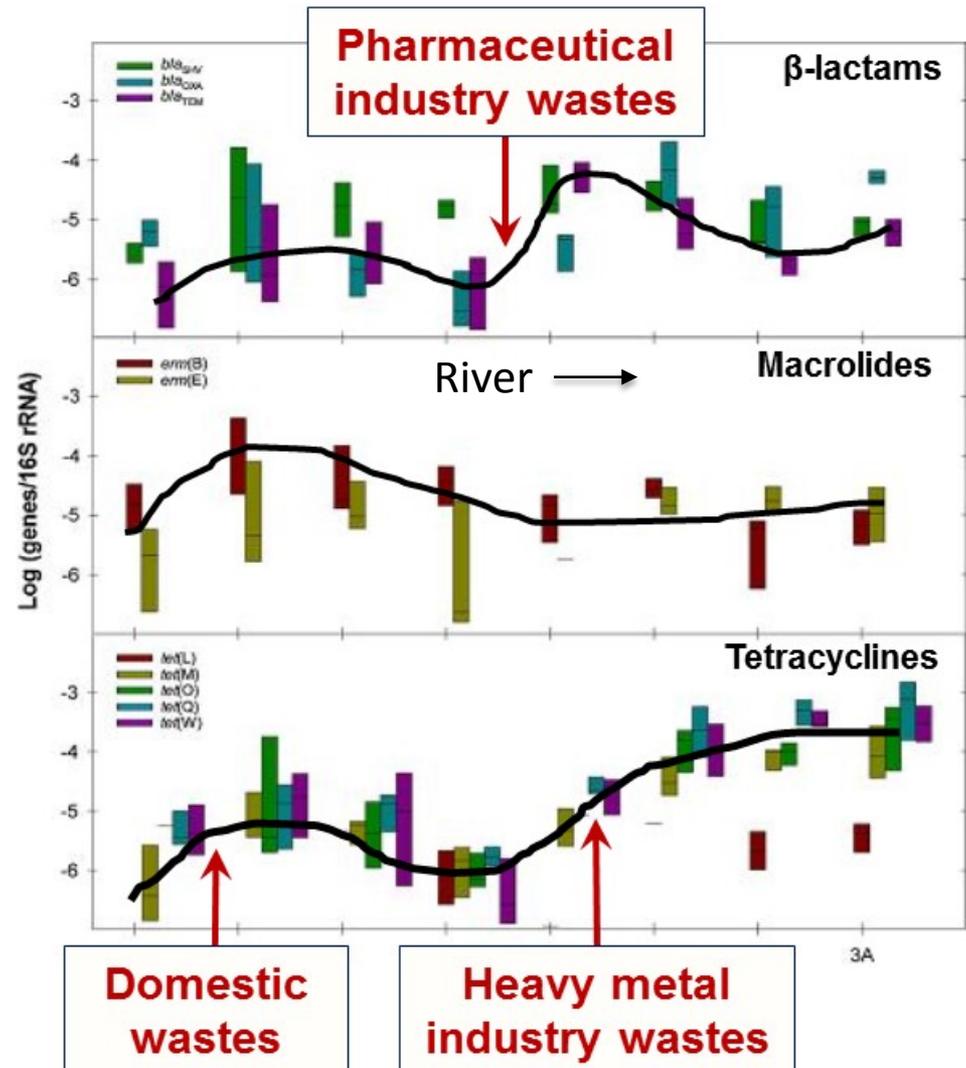
- None, therapeutic vs. non-therapeutic use

- If antibiotics were used, AR is gained in the whole herd
- Wastes are driving AR spread?

Untreated domestic and industrial wastes drive AR

- AR in the Almendares River in Cuba
- Antibiotics are used very prudently
- Industrial and domestic wastes dominate environmental AR exposures

Graham et al. 2011. Antibiotic resistance gene abundances associated with waste discharges to the Almendares River near Havana, Cuba. *Environ. Sci. Technol.* 45: 418-24.



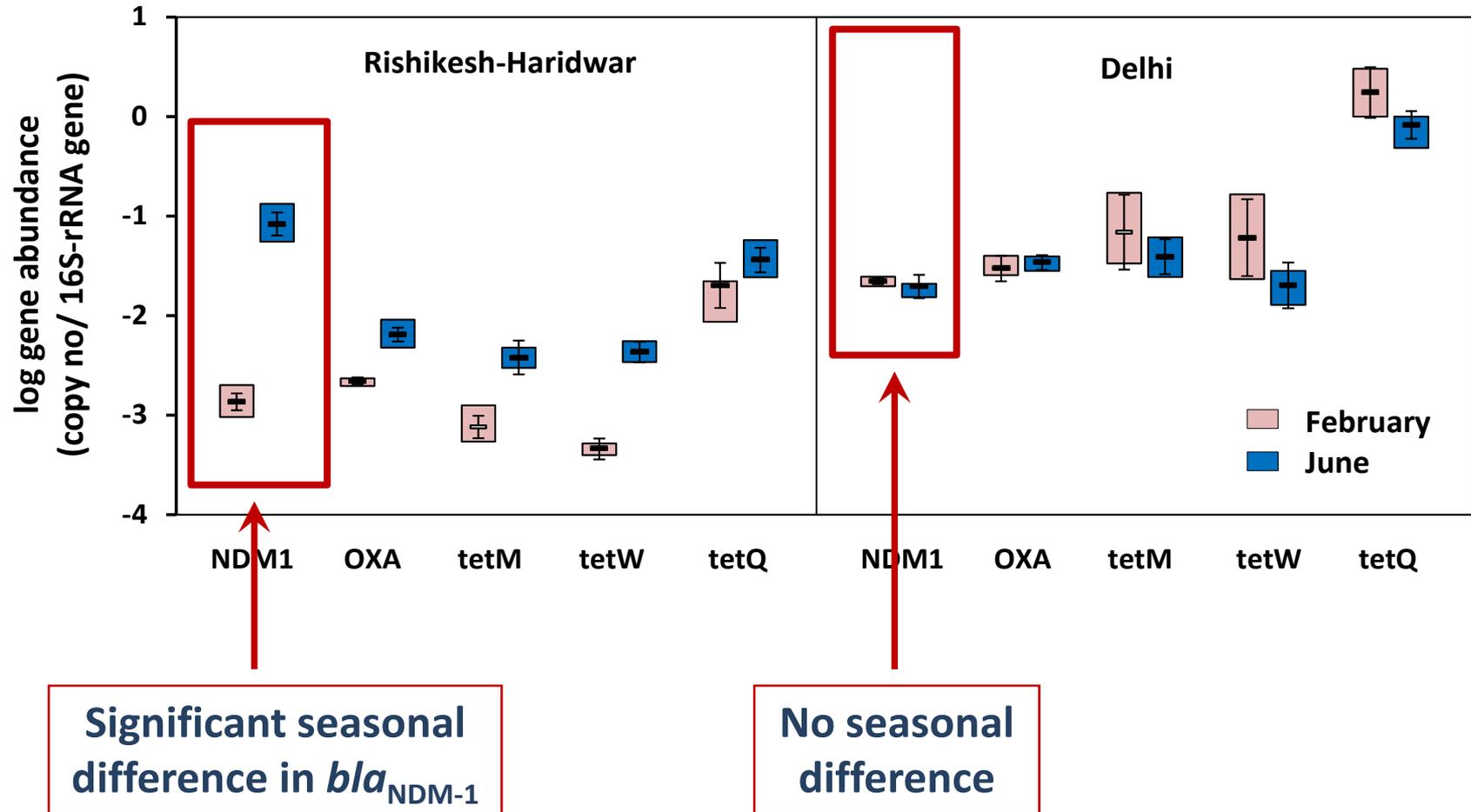
Human migration and $bla_{\text{NDM-1}}$ dispersal

- NDM-1 protein = multi-resistance
- First noted in Delhi (2008), but now global
 - Very mobile (plasmids)
 - Pilgrimages to pristine locations
- Compare $bla_{\text{NDM-1}}$ in water between urban areas and pilgrimage sites

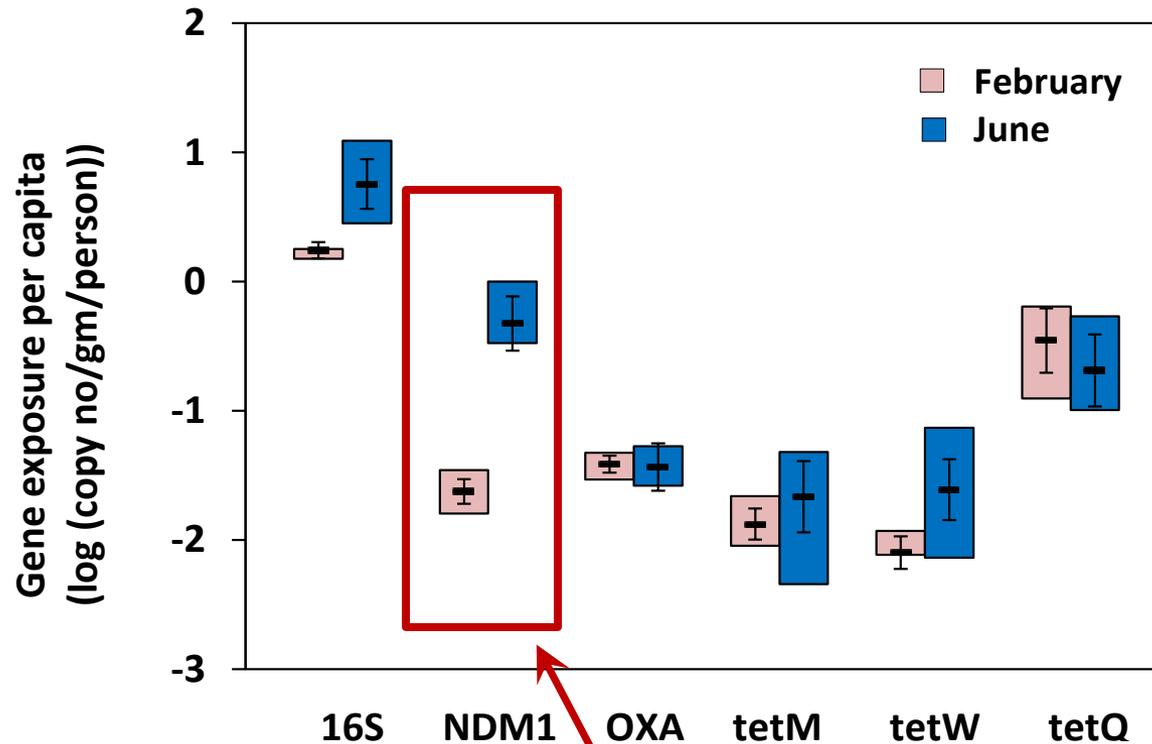


Population increases from 300k to 1.0-1.5M

Seasonal *bla*_{NDM-1} exposures



*bla*_{NDM-1} per capita in visitors



Visitors have more *bla*_{NDM-1} in their wastes than residents.

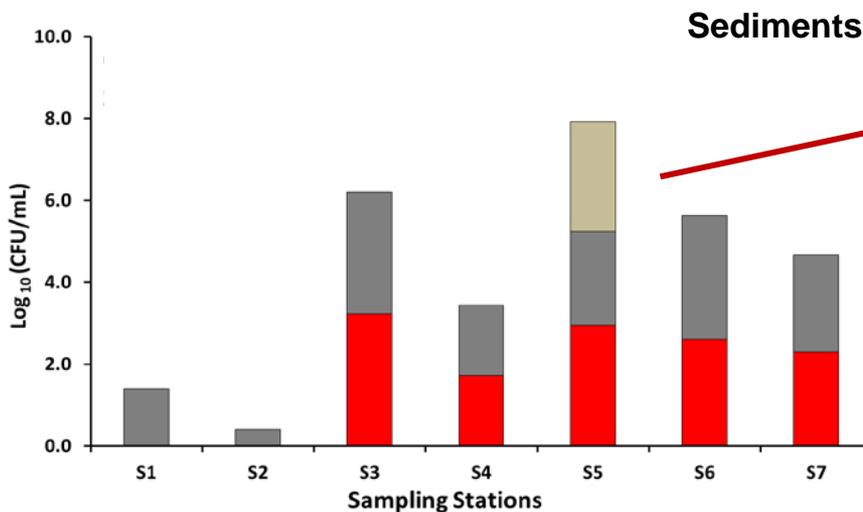
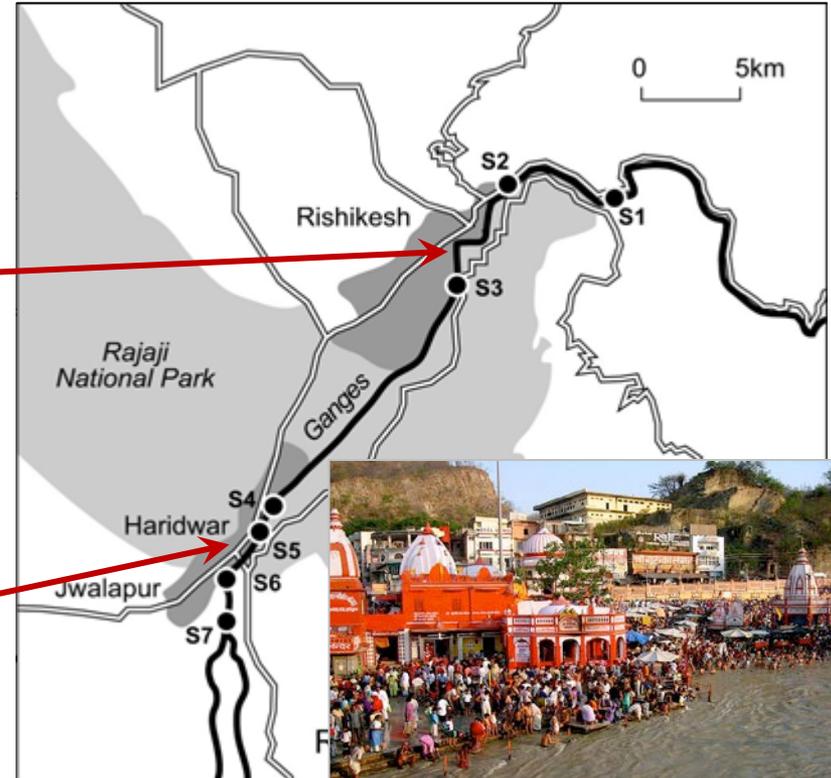
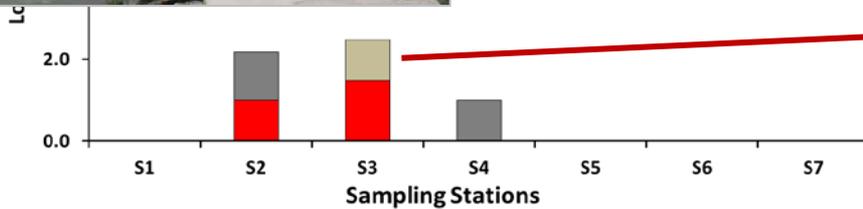
<http://www.bbc.co.uk/news/health-28368313>

Carbapenem-resistant isolates of apparent fecal origin



Water column

- Unknown
- Enterobacter spp./ Klebsiella spp./ Serratia spp./ Aeromonas spp.
- E. coli



including numerous *bla*_{NDM-1} positive pathogens

Observations

- Antibiotic use and regionally poor water quality drive the global spread of AR
- Developed countries are complacent because of locally clean water
 - AR is massively discharged in wastes where management is limited
 - International travel (human, wildlife) spreads local AR to global scales
- “One Health” strategies must include:
 - “Wastes” and globally improved water quality
 - International environmental surveillance

