Scientific Challenges for the Implementation of the WFD

(with a bit on training)

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Requirements of the WFD

1. Prevent the deterioration in the status of all groundwater bodies

2. Enhance and restore deteriorated bodies of groundwater with the aim of attaining "good groundwater status"

Requirements of the WFD

For groundwaters:

- Good quantitative status is

Recharge > Abstraction
Insignificant adverse ecological impact

- Good chemical status is

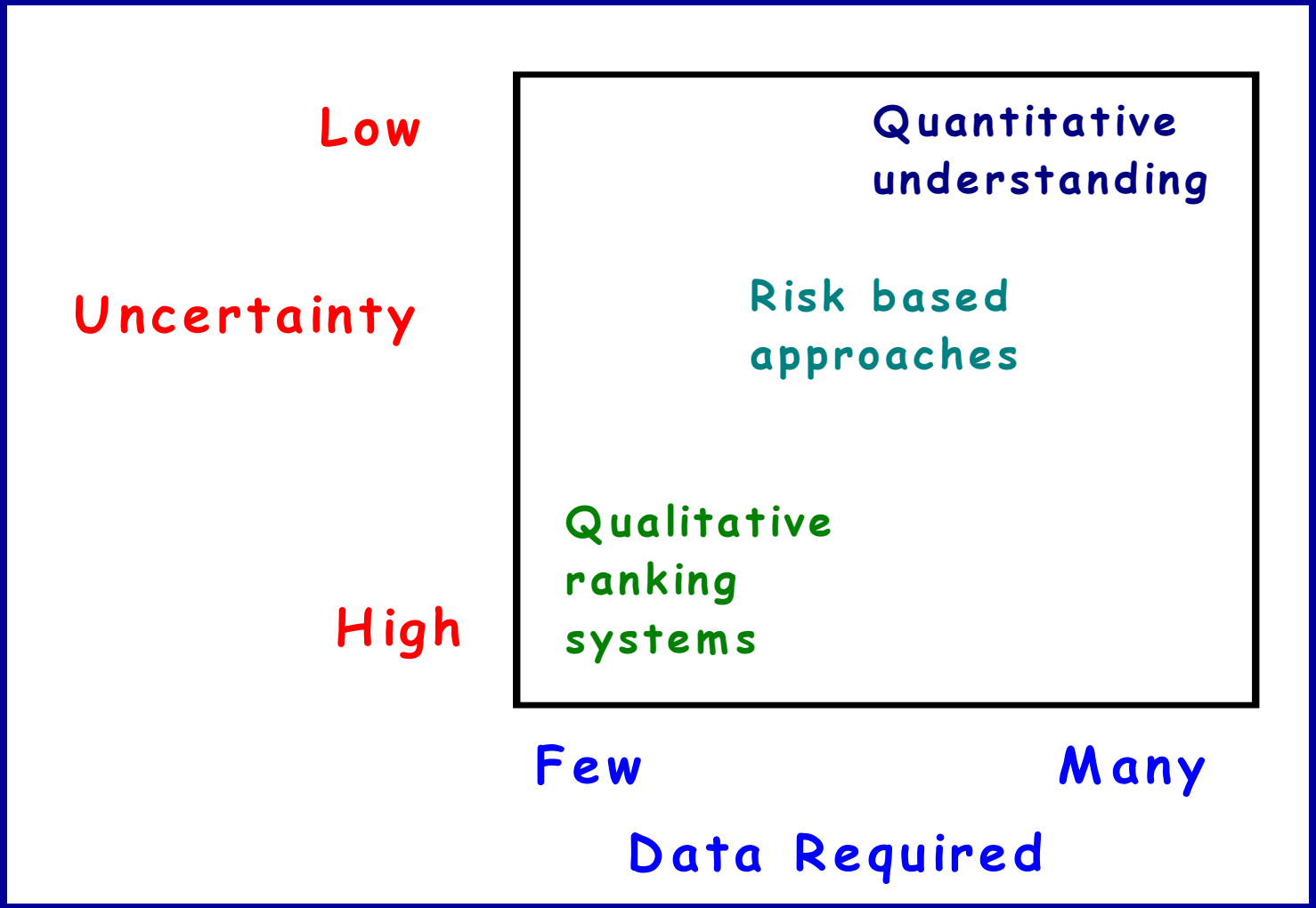
Pollutant concentrations < Quality limits
Insignificant adverse ecological impact
Insignificant induced intrusion

Knowledge Required

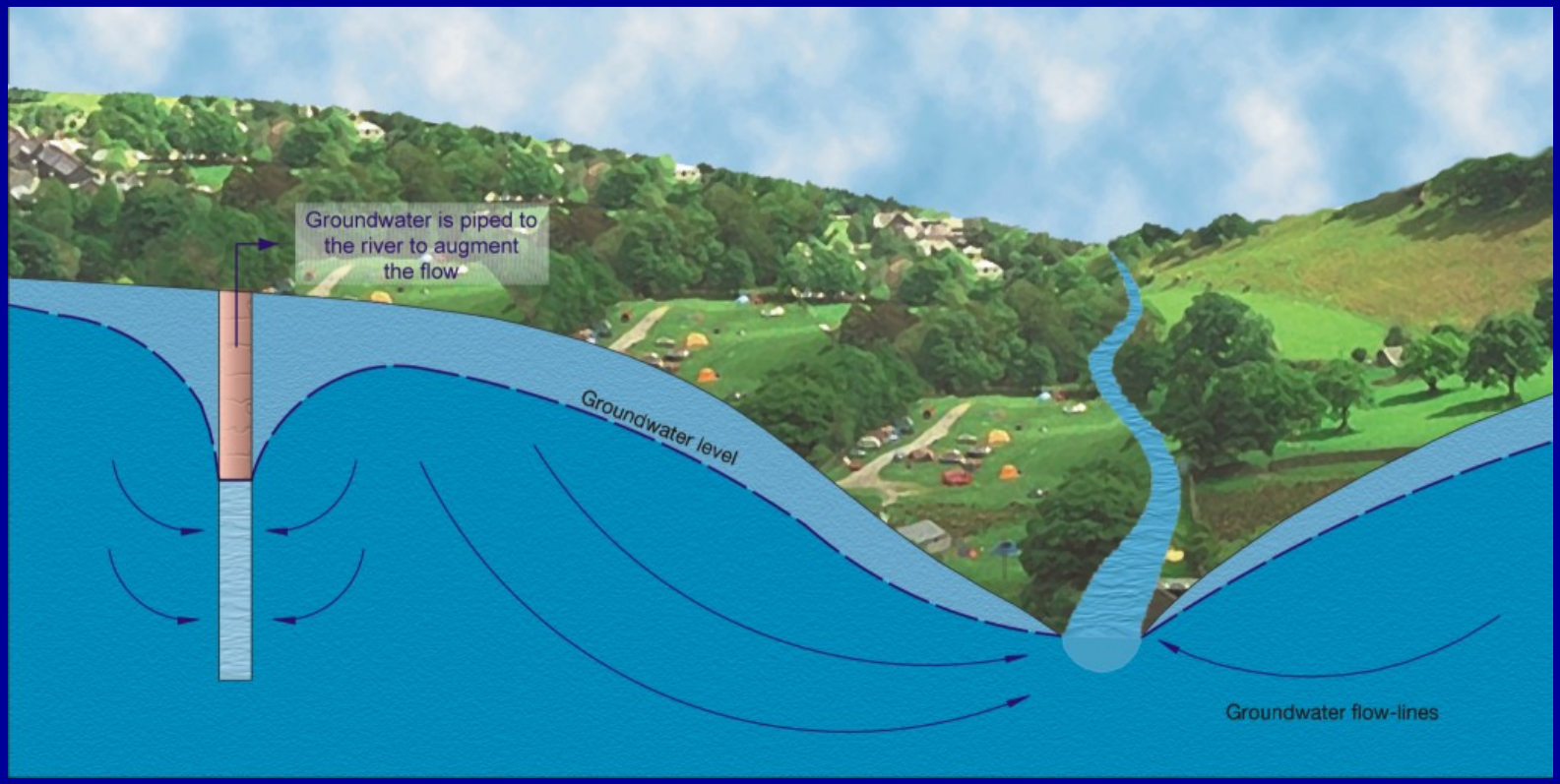
- Flow rate distributions (x, y, z, t)
  - Requirements 1, 2
- Velocity distributions (x, y, z, t)
  - Requirements 1, 2
- Chemical reactions (x, y, z, t)
  - Requirements 1, 2
- Ecosystem/Flow/Chemistry relationships
  - Requirement 1, 2

Nothing New!

Current Knowledge



Current Knowledge



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Main Issues

- Heterogeneity
- Data
- Understanding of processes

Main Issues: Heterogeneity

- Scales of heterogeneity, measurement, calculation, and interest – space & time
- e.g. Measure @ scale of < 10s metres

  Calculate @ scale of 10-100s metres

  Manage @ scale of 100s m - kms

  in a system with scales of heterogeneity from metre to 100s m scale

  ?are the measurements at the right resolution?are there enough?
- How should we up-scale?

Main Issues: Heterogeneity

- **Flow rates**, *e.g. upscaling of tensiometer/lysimeter data*
- **Velocity distributions**, *e.g. b/h data will average out v, piezo data may miss extremes*
- **Chemistry**, *e.g. measure at well scale, interpret at molecular scale*
- ***We are always seeing the system through the bias of the sampling device***

Main Issues: Data

- Need >>> 4D hydraulic & chemical data
- Covered by previous talk
- Absolute values, at a range of scales? which are?
- Data on uncertainty/distributions
- Correlations between hydraulic & chemical properties

Main Issues: Processes

- Flow
  - basic *processes* fairly well understood?
  - implications < well understood?
    - e.g. unsaturated zone
- Chemistry
  - many processes need quantifying
    - NH_4 sorption, redox, organic complexes
    - kinetics

Current Research

- Mainly short-term
  - regulatory-driven
    - need to provide defensible decisions quickly
    - reactive research environment
  - EA, UKWIR, Research Council funded
- Long-term, basic research largely untargeted
  - e.g. unsaturated zone
  - e.g. tracer work
  - e.g. μ2M, trend to user-lead thematic programmes, LOCAR

Future Research

- Short-term research
  - has natural market force support, and is best lead by EA & industry
- Long-term strategic research
  - brings limited immediate benefit to individual industries or even the EA
  - Research Councils ideally placed to take a lead

Future Research

- Need to recognize:
  - hydrogeology is unlike, say, atmospheric chemistry in that cannot necessarily transfer results from other systems
  - we cannot rely on N America or even EU - we have to examine our own unique systems
  - the costs of research are significant, partly because our aquifers are deep and hard (Sellafield!)

Who Will Do the Work?

- Currently consultancies, EA, Water Companies, BGS all find difficulty in filling vacant posts.
- Shortages of suitably qualified people - likely to get worse
- Why?

Who Will Do the Work?

- fewer numerate school leavers
- fewer applications for hydrogeology courses
- fewer courses
- poor salaries
- student indebtedness
- advent of MSci degrees

Future Staffing

- The work load is increasing, but the work force is decreasing, i.e.
- The study and practice of hydrogeology, hydrology, and associated disciplines may be approaching crisis …..

- Numerate ecohydrogeologists …...

Conclusion

- Many opportunities
- Reactive research environment – dominated by short-term goals
- More long-term research needed if the spirit of the WFD is to be honoured
  - heterogeneity, data, processes
  - recognize the costs
  - recognize the uniqueness of our aquifers
- Personnel issues