Characterisation of the groundwater environment for resource assessment, development, management and protection

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Outline

- Irish groundwater systems
- Aquifer classification
- National ‘groundwater’ datasets
- Characterisation of the groundwater environment for resource evaluation, development, protection and management
- Areas requiring further research
- Conclusions and the future…
Groundwater occurrence in Ireland

- Groundwater occurs in useful amounts in:
  - Sand and Gravel deposits
  - Bedrock
Sand and Gravel aquifers

- Groundwater flows around the grains of gravel/sand
- More groundwater through gravel
- Less (but significant) volumes through sand
- Size and saturated thickness criteria
Bedrock aquifers
Bedrock aquifers

• Permeability development depends
  – mainly on faulting and fracturing
    • width
    • density
    • connectivity
Fissures as fluid pathways

Fissures generally localised, small and poorly connected

Larger faults, wider and better connected fissures

- e.g. Granites, Old Red Sandstones, rocks of NW
- e.g. Volcanics, Impure limestones at Clones
Fissured rock aquifers

- Flow between sand/silt grains unusual
- Permeability development depends:
  - mainly on faulting and fracturing
  - also on flow along bedding planes and joint surfaces
Joints & bedding planes as fluid pathways

Impure Limestone
Bedding planes and fissures as fluid pathways
Fissured rock aquifers

- Flow between sand/silt grains unusual
- Permeability development depends:
  - mainly on faulting and fracturing
  - also on flow along bedding planes and joint surfaces
  - and on weathered zone at top of the rock
Weathered zone as fluid pathway

D. Daly
Karstified limestone aquifers
Karstified limestone aquifers

D. Daly
Aquifers

- Different groundwater transmitting capabilities
- Heterogeneous & complex

⇒ How do we make sense of natural variability?
Aquifer characterisation

• Hydrological indications of groundwater storage & movement, e.g.
  – presence of large springs (-> good aquifer)
  – high groundwater flows to rivers (-> good aquifer)
  – high % of high yielding boreholes (-> good aquifer)
  – high % of high productivity boreholes (-> good aquifer)
  – absence of surface drainage (-> high permeability)
  – high surface drainage density (-> low permeability usually)

• Correlate with bedrock type and/or geological structures (e.g. faults, bedding)

• Extrapolate correlation to data-poor areas
Aquifer classification

- Aquifer type
  - Gravel
  - Fissure
  - Karst

- Aquifer resource value
  - Regional
  - Local
  - Poor
Scale of aquifer classification

- Characterise the spaces between the solid bits
- "Helicopter view"

Burren, Co. Clare
National Aquifer Map

Bedrock aquifers

Regionally Important
- Rk Karstified

Locally Important
- Lm Generally moderately productive
- Lf Fissured bedrock
- Li Moderately productive only in local zones
- Lk Locally important karstified aquifer

Poor
- Pi Generally unproductive except for local zones
- Pu Generally unproductive

Gravel aquifers

Regionally Important
- Rg

Locally Important
- Lg
National Soils and Subsoils Maps

Subsoils

Soils
Where we’re at

- Resource potential =>
  - Aquifer category map

- Resource evaluation =>
  - Aquifer map + Recharge map

- Groundwater protection =>
  - Vulnerability + Aquifer + Groundwater Protection Responses

- Groundwater pollution risk maps =>
  - Soils + Vulnerability + Aquifer + Pressure

- Runoff risk maps =>

- Hydrological catchment modelling =>
  - Aquifer + Vulnerability + Subsoil perm + Soils + ....
Resource potential

- Aquifer category indicates:
  - **Range** in likely yields, drawdowns
    (capacity for pollution attenuation)
  - Groundwater flow system size
    (pollution transport distance)

Fitzsimons *et al.*, 2005
Resource evaluation

Kelly, 2001; Misstear et al., 2005

Meenymore Formation  Dartry Limestone

Later pumping rates (examples)

<table>
<thead>
<tr>
<th>Year</th>
<th>m³/day</th>
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<tbody>
<tr>
<td>1988</td>
<td>500 (av)</td>
</tr>
<tr>
<td>1995</td>
<td>250-600</td>
</tr>
<tr>
<td>1998</td>
<td>300-400</td>
</tr>
</tbody>
</table>

PW-C: 1996: 450-600
PW-D: 1997: 350-750
MCC: 1985: 912
TGWS-Burns: 1992: 300-800

No Change
Well abandoned 1988
Well abandoned 1993
Resource evaluation

• Sustainable groundwater resource
  – related to long-term recharge
• Function of subsoil and aquifer properties
• Individual source development
  – local aquifer characteristics influence sustainable yield
• Can begin to assess groundwater resource more ‘holistically’
• BUT – not all long-term recharge is there to be abstracted!
Knowledge gaps

• Testing of aquifer conceptual models
  – particularly less productive fractured bedrock aquifers

• Groundwater flow system characterisation
  – effective aquifer thickness, transmissivity, storativity

• Groundwater recharge
  – amount, timing, location

• Prediction of abstraction impacts
  – distances from receptors

• How to reconcile aquifer scale conceptual models and parameters with site scale
Addressing knowledge gaps

Funded research projects

- **Griffiths**
  - QUB – groundwater flow in poorly productive bedrock at local and larger scales, GW-SW interactions
  - NUIG – karst aquifer linkages with coastal surface and transitional waters

- **STRIVE**
  - GW-SW interactions and contaminant migration pathways
  - Groundwater-dependent ecosystems

- **Completion of subsoil permeability mapping**
  - National Development Plan
Some future directions & challenges

• Shorter term
  – Characterising geothermal potential
  – Making preliminary assessment of climate change impacts

• Longer term
  – Improving conceptual model
  – Enhancing maps and databases
    • Subsoil permeability
    • Aquifer parameters
    • Fracture zonations
Finally

- Highlighted achievements in national mapping and data applications
- Indicated areas that need improved understanding
- Outlined some areas for future work
  - shorter and longer term

- Very interested to hear opinions from the floor
  – priorities?
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