Quantification, acceptability and sustainable water management options in the UK – the role of HIA

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Four year EPSRC-funded project looking at water cycle management for new developments.

Main areas of investigations were:

- Water supply;
- Water demand management;
- Wastewater management; and
- Stormwater management

Research included social, environmental, health and sustainability aspects and not just hard engineering.
With increasing pressure on water supplies, especially in the south east of England, it is possible that rainwater harvesting and the reuse of greywater could be advocated in new developments to reduce water use.

Household rainwater harvesting is already in place in some individual properties and small-scale developments.
Opinions in the water and construction industries on these ‘new’ technologies vary widely and seem to range from – ‘what’s the problem?’ to ‘we’re all going to die!’

I was interested to have a sensible look at the hazards and risks and so this work examines the possible health consequences of installing these new systems by performing HIAs on a hypothetical population living on a new development in the south of England.
Quantification

- To compare the different technologies, look at vastly differing health outcomes (e.g. death and stomach upsets!) and appeal to my mainly engineering colleagues I needed, as far as possible, to quantify the results!

- Disability adjusted life years (DALYs)
Quantification of the identified health impacts (where possible) using Disability Adjusted Life Years (DALYs)

DALYs are a combination of:

- years of life lost (YLL) by premature death,
- years of life lived with a disability (YLD) (standardised using severity weights, which range between 0 – perfect health and 1 - dead)
Setting the boundaries - scoping

- Population covered: hypothetical population living on a newly built estate in the South of England;
- Timescale: a year from when the development is complete and (essentially) fully occupied;
- Geographical boundaries: the housing development
It was assumed that each property has a household rainwater system, with an underground tank (collecting rainwater from the roof via downpipes and a filter), which is used for garden activities and toilet flushing (with separate non-potable plumbing) and is the responsibility of the individual householder.
Rainwater harvesting - concept
Rainwater harvesting
Rainwater harvesting
Scenario (greywater reuse)

- Greywater
- Sewer overflow
- Reeds – up to 2m high
- Disinfection
- Unrestricted garden watering
Proiling

- 2001 census data;
- Population density 2.54
- Over 1800 houses;
- Projected population 4746
- Age profile:
  - 0-4  471  (9.9%)
  - 5-15  634  (13.4%)
  - 16-64  3532  (74.4%)
  - 65+  109  (2.3%)
Selection of hazards

Drowning

Injury

Infection

"Well, sod Daddy's needs - it's time you took care of yourself for a change!"
Some microbial routes of exposure

- Toilet flushing
- Skin contact
- Vector-borne
- Cross connections
- Mutant vegetables!
- Drinking from garden tap
Health impact statement: in-house rainwater harvesting

Overall DALY score 4.59 x 10^{-4}

Annual DALYs in the case study population

- Drowning
- Injury
- Campy toilet flushing
- Campy direct ingestion (external tap)
- Crypto direct ingestion (external tap)
- Campy X-connection
- Crypto X-connection (normal)
- Crypto X-connection (immunocomp)
- Respiratory infection via aerosol
- Skin infection via dermal contact
- Crypto from garden produce (normal)
- Crypto from garden produce (immunocomp)
- Vector-borne illness
Acceptability

- WHO drinking water quality guidelines suggest a tolerable disease burden of $1 \times 10^{-6}$ DALYs per person per year
  - Rainwater harvesting estimate an order of magnitude less than this;
  - Greywater reuse with a garden constructed wetland is an order of magnitude greater than this;
  - But fenced is an order of magnitude less.
Acceptability

- Typical level of campylobacteriosis in the UK each year – based on correcting for known under reporting for the case study population would result in a DALY score of 0.12 – is that acceptable? Is half of that acceptable?
Acceptability

- What happens if we don’t institute water saving measures and we have a drought every five years resulting in rota cuts?
- Estimates based on increased stomach upsets (from poor personal hygiene) and scalds (from the associated boil water notice) suggest a DALY score of 0.049 per drought event.
- If a drought occurred every five years this would give an annual score per person of $2 \times 10^{-6}$ – is anything less than this acceptable?
Context

- Greywater CW
- Greywater CW - fenced
- RWH (hh system)
- Drinking water acceptable risk
- Drought scenario
- Annual burden of campylobacteriosis

Annual DALY score for case study population

0 0.02 0.04 0.06 0.08
Conclusions

- Results are *indicative* at a population level — it is clearly not possible to have half a broken bone;
- It is necessary to make quite a lot of assumptions — some of which are backed up by more data than others;
- DALYS are useful — and the engineers seem to quite like them — but what about things which can’t be quantified (e.g. where there is no dose-response relationship)?;
- Non quantifiable impacts can’t be ignored.