Reservoir Safety and Climate Change: a briefing note.

By David Crichton, June 2007.

Background

According to a report for Government[1], climate change will increase the risk of failure of the 5,000 dams in the UK for a number of reasons:

- Summer droughts will lead to more subsidence of earth embankments.
- Stronger winds will lead to increased wave activity in reservoirs which could lead to overtopping and erosion.
- More severe rainfall events will lead to sudden loadings on embankments and spillways.

The risk of failure due to a rainfall event is likely to come at a time when there are general flood problems in the area. UK fire and rescue services concluded[2] in 2006 that *"the UK simply does not currently have the capability to respond to a major flood event."* So they may only be able to provide limited assistance to the dam undertaker in an emergency. There is a risk of landslip into the reservoir in hilly areas which could cause catastrophic overtopping of the dam as happened in Vaiont, Italy in 1963 when over 1,000 people died. In addition, dams present attractive and often unguarded targets for terrorists.

Many dam failures around the world have been due to severe rainfall events[3]. In the USA the rate of dam removal has exceeded the rate of construction for the last ten years with 80 dams removed in the last two years mainly for safety reasons[4].

In the UK the operators of reservoirs have a strict legal liability for any injury loss or damage resulting from escape of water[5]. For large above ground reservoirs they have an obligation to have the dam and embankments inspected for safety at least every ten years by a specially qualified engineer under the Reservoirs Act 1975 as amended by the Water Act 2003. In England and Wales, responsibility for safety enforcement was passed from local authorities to the Environment Agency[6] in October 2004. In Scotland responsibility for enforcement remains with local authorities.

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[1] Babtie Group and the Centre for Ecology and Hydrology, 2002. "*Climate Change Impacts on the Safety of British Reservoirs*" defra, London.

[2] Hayden, P, November 2006. *"Management of major flood events: Fire and Rescue Services contribution to the emergency phase; report for the Chief Fire Officers Association Board*." Chief Fire Officers Association, UK

[3] Bosshard, P., and Switkes, G., 2004. *"Rash of Dam Failures Raise Safety Concerns*" World Rivers Review Vol. 19 No. 4, p7. August 2004. International Rivers Network, Berkeley, California, USA

[4] Marks, J. March 2007. *"Down go the Dams*" Scientific American, March 2007.

[5] Rylands v. Fletcher (1868) L.R. 3 H.L. 330; [203 L.T. 82; 204 L.T. 237; [1956] C.L.J. 13; 23 Sol. 191; 72 L.Q.R 311; 19 M.L.R. 419; 100 S.J. 659; 11 Conv. 259; 11 I.C.L.Q. 937; 3 Legal Executive 3; 121 New L.J. 183]; affirming sub nom. Fletcher v. Rylands 91866) L.R. 1 Exch. 265.

[6] The Environment Agency is not responsible for the safety of small reservoirs, reservoirs in mines and quarries, or for canals or tidal barrages. These come under the Health and Safety Executive.

Many UK dams were constructed during the severe dry spells (1850s, 1880s, and 1890s) at the start of the Industrial Revolution[7] in order to provide water for power and textile processing. The average age of large dams in England is 110 years[8].

There are 2010 large reservoirs[9] in England, 680 in Scotland, and 70 in N. Ireland. The biggest reservoir undertaker is Scottish Water. The biggest undertaker in England is the Environment Agency.

ULLEY Reservoir Incident, 26th June 2007.

Ulley Reservoir is a 35 acre reservoir, up to 10 metres deep and holding 580 million litres of water. It was built in the 1870s to provide a water supply for Rotherham. Latterly it has been used for fishing and sailing. The 25th June recorded the highest ever June rainfall in a single day and the dam was declared in "imminent danger" of collapse. 13 pumps were brought in from surrounding areas for an emergency "draw down" to reduce water levels in the reservoir. It is not known why they did not open the sluice gates to reduce the water levels more quickly. According to Mr Milliband (Commons statement on 26th June 2007) on this occasion the fire service used their new high volume pumps supplied by DCLG to some brigades in England[10]. Despite this they were initially unable to keep pace with the amount of water flowing into the reservoir.

Press reports state that in the morning of the 26th June, 700 people were evacuated from the villages of Treeton, Catliffe and Whiston. Some evacuees claim that they were woken without warning at 2.30 am and given 5 minutes to get dressed and go to waiting coaches. Many did not have time to take essential medication with them let alone pack sentimental items. It is not known why they could not have been given more notice, for example at the time the coaches were ordered. Press reports indicate that some evacuees were apparently ignorant that they lived in the danger zone of the reservoir and never expected an evacuation.

Going by aerial images the spill way led the water straight into villages downstream resulting in serious flooding there. It is not known why the houses were built in the path of the spillway or in the dam break danger zone.

There has not been any loss of life from a dam failure in the UK since 1925 and there is no reason to suppose that any particular dams are dangerous. But there is cause for concern:

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[7] Barker, P A, Wilby, R L, & Borrows, J., 2004. *"A 200-year precipitation index for the central English Lake District"* Pp 769-785 Hydrological Sciences–Journal–des Sciences Hydrologiques, 49(5) October 2004.

[8] Hope, I., 2007. "*Development of Flood Plans for Large Raised Reservoirs in England and Wales."* Environment Agency, Exeter.

[9] As defined in the Reservoirs Act 1975.

[10] These may be the new pumps intended for use in drought conditions where standpipes cannot deliver enough water for fire fighting and water has to be pumped from standing water some distance away. They can pump 8,000 litres a minute and are supplied with 3km of 150mm hose which they can lay automatically.

- On average large English reservoirs are over 110 years old[11].
- The latest PS InSAR[12] satellite monitoring equipment can give advance warning of failure by very accurately detecting sub millimetre movement of embankments, but in the UK this is only used on one reservoir.

The Environment Agency has produced a report[13] which claims that 69% of large dams in England pose a threat to human life, but it does not identify which dams.
In addition, the Environment Agency say that each year there are on average six emergency draw downs in England to reduce water levels to prevent collapse[14].

Future outlook

More dams will be needed to help with adaptation to climate change:

- Severe water stress in the South East of England combined with plans for new housing in that area means that the biggest reservoir to be built in England for 25 years is planned by Thames Water at Abington near Oxford to provide water supplies. Construction is planned to start in 2011. A further three large reservoirs are planned for the South East and three more will be enlarged.
- Demand for renewable energy will also lead to the construction of new dams. The biggest conventional hydro electric dam to be built in the UK for almost 50 years is currently under construction[15].
- More dams will be needed for flood defence.

Comments from David Crichton

Dams are increasingly important to society in helping to adapt to climate change impacts. The whole system of risk management for reservoirs was reviewed in detail[16] in 2000 and there is now much more openness about safety issues especially since the Environment Agency took over enforcement in England and Wales in 2004. This is very welcome, but the age of the stock of dams in this country must be a continuing concern, especially in the light of climate change and the legacy of new building over many years in the danger zones below dams.

Much of this new building is due to the secrecy which has characterised the industry for many years and it was only after the Freedom of Information Acts

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[11] Hope, I., 2007. "*Development of Flood Plans for Large Raised Reservoirs in England and Wales.*" Environment Agency, Exeter.
[12] Permanent Scatterer Synthetic Aperture RADAR Interferometry
[13] Environment Agency, 2007. "A better place to live; Working together for the safety of our reservoirs." 13pp Environment Agency, Exeter.
[14] **Hope, I., 2007. *"Development of Flood Plans for Large Raised Reservoirs in England and Wales."* Environment Agency, Exeter**
[15] See http://www.glendoe.co.uk/
[16] Hughes, A; Hewlett, H W M; Samuels, P G; Morris, M; Sayers, P; Moffat, I; Harding, A; and Tedd, P. 2000 *"Risk Management for UK Reservoirs."* Construction Industry Research and Information Association (CIRIA) Research project report C542. London.

which came into force on 1st January 2005 that access to engineers' inspection reports became more readily available. Even now, access to dam break inundation maps is still refused on the grounds of national security, although publication is promised in the future as part of government strategy for better emergency planning. It is also proposed to publish a register of dam incidents in the future and this is currently being prepared[17] .

In the meantime from an insurance point of view, it is very difficult for liability insurers to quantify their exposures in such a climate of secrecy and this has implications for the abilities of liability insurers to comply with the EU Solvency II Directive.

Further information

Environment Agency 7 September 2006. *"Views sought on new dam safety plan"* Environment Agency Press Release, Exeter
Available from http://www.environment-agency.gov.uk/news/1465403

Environment Agency, 2007. *"Learning from experience; post incident reporting for UK dams."* 17pp. Environment Agency, Exeter.
Available from http://www.environment-agency.gov.uk/commondata/acrobat/dams_brochure_1747418.pdf

Environment Agency, 2007. *"A better place to live; Working together for the safety of our reservoirs."* 13pp Environment Agency, Exeter.
Available from http://www.environment-agency.gov.uk/commondata/acrobat/rs_brochure_english_1714651.pdf

[17] Environment Agency, 2007. *"Learning from experience; post incident reporting for UK dams."* 17pp. Environment Agency, Exeter.