Physical resources

Fracking unlikely in Europe (*March 2016*)

These days, leading British politicians burdened with power have a tendency to show outwardly that they are, if little else, earnest. When busy with economic and industrial policy they wear tailored day-glo hi-viz suits and shiny new hard hats. During the great 2015 floods of Northern England, their garb was off the peg North Face gear and green wellington boots. And, of course, for social policy a hoodie is *de rigueur*. Rosy-cheeked Prime Minister David Cameron has been extremely earnest about fracking for shale gas for several years, and in the petroleum industry the appropriate signal of a leading politician's enthusiasm is to wear a rigger's blue jumpsuit; 'We're going all out for shale' Cameron has said. Given the explosive success of shale-gas exploitation in North America over the last decade that's not very surprising, but do not expect to see him again looking earnestly at an exploration rig any time soon.

Cameron's excitement began when in 2011 the Advanced Resources Institute (ARI) in Washington DC released the results of its consultancy for the US Department of Energy on global shale-gas prospects. The star prospect in Europe was Poland, well endowed with subsurface shales, which according to ARI, had more than 5 trillion cubic metres of technically recoverable reserves, enough to satisfy Polish consumption for more than 300 years. In 2013, ARI suggested 17 trillion m^3 beneath Britain, albeit only 0.7 trillion that was amenable to fracking (about a decade's worth of British gas consumption). But still the hype was maintained. An article in the 3 March 2016 issue of *Nature* (Inman, M. 2016. Can fracking power Europe. *Nature*, v. **531**, p. 22-24) tempers enthusiasm a great deal more.

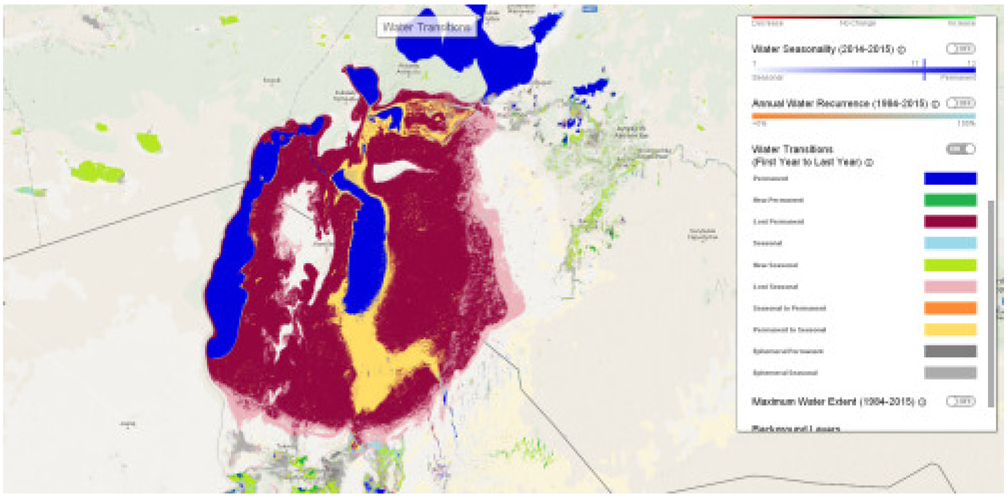
The Polish Geological Institute revised the country's reserves down to a tenth of ARI's estimate. After an initial frenzy of interest following the ARI report, when exploration licences covered a third of Poland, during 2013 and 2014 major companies relinquished licences for fracking *en masse*. Their exploratory activities had been disappointing because of the depth of burial (2-5 km compared with 1-2 km in the US) and unfavourably high clay content and strength of the target shales. The less thrilling ARI prospects for Britain did not excite major petroleum players at all, what interest there is being from 'juniors' such as Cuadrilla. The British Geological Survey, which has huge archives of geological information, both surface and subsurface, has assessed the three main British shale-gas 'plays' and comes up with a reserve figure of between 24 and 68 trillion m^3. But that high figure is based on the situation in mid-west North American shale-gas fields, where the geology is a great deal simpler than here. In Britain, orogenies at the end of the Carboniferous and the outermost ripples of that which formed the Alps in late Mesozoic and Palaeogene times created far more deformation than beneath the central plains of North America. Widespread faults, even though few in Britain have large displacements, pose two sets of problems. As the minor earthquakes set off by fracking in the tectonically simple Fylde area of western Lancashire indicate, pumping fluids into faulted rock can release pent-up elastic strain. But such leakage into faults and smaller fractures may also cause the injection pressure to fall, making the fracking process less efficient.

Inman reports that fracking is now moribund throughout Europe, partly because of the disappointing results and also because environmental concerns for densely populated regions have spurred widespread moratoria, including those in three of Britain's four nations; Scotland, Wales and Northern Ireland. The only current European fracking activity is in England, conducted by a handful of junior companies. A stumbling block in England actually lies with the quality of subsurface data for what has been described at the most close examined geology in the world. Since the early 1980s there has been a succession of onshore licensing rounds for oil and conventional gas, the 14th of which is still active. The early ones were accompanied by a great deal of seismic reflection surveying, mainly using the truck mounted 'Vibroseis' method where the ground is mechanically thumped rather than subject to explosive shot firing that is favoured in sparsely populated areas. According to BGS, the guardians of the onshore seismic exploration repository, compared with the onshore seismic data available in North America that for Britain is 'sparse, and fairly poor'.

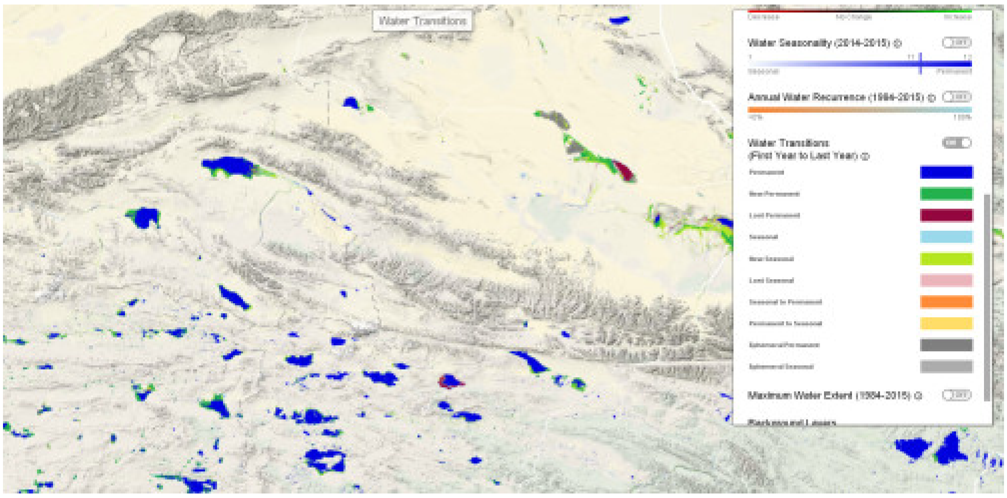
'Big data' on water resources (*December 2016*)

Two petabytes (2×10^{15}) is a colossal number, which happens to approximate how much remotely sensed data has been collected by the Landsat Thematic Mapper and its successors since it was first launched in 1984. In tangible form these would occupy about half a million DVDs, weighing in at about 8 metric tonnes; 'daunting' comes nowhere near describing the effort needed to visually interpret this unique set of multi-date imagery. Using the Google Earth Engine, the free cloud-computing platform for big sets of image data which hosts all Landsat data and much else (but not yet the equally daunting ASTER data – roughly a million 136 Mb scenes) the 32 years-worth has been analysed for its content of hydrological information by the European Commission's Joint Research Centre in Italy, with assistance from Google Switzerland. Using the various spectral characteristics of water in the visible and infrared region, the team has been able to assess the position on the continents of surface water bodies larger than 900 m^2, both permanent and ephemeral, and how the various categories have changed in the last 32 years (Pekel, J.-F. *et al.* 2016. High-resolution mapping of global surface water and its long-term changes. *Nature*, v. **540**, p. 418-422; DOI: 10.1038/nature20584). The results are conveniently and freely available in their entirety at the Global Surface Water Explorer, an unparalleled and easy-to-use opportunity for water resource managers, wetland ecologists and geographers in general.

Among the revelations are sites and areas that have been subject to gains and losses in water availability, the extents of new and vanished permanent and seasonal water bodies and the conversion of one to the other. A global summary gives a net disappearance of 90 thousand km^2 of permanent water bodies, about the area of Lake Superior, but exceeded by new permanent bodies totalling 184 thousand km^2. There has been a net increase in permanent water on all continents except Oceania with a loss one percent (note that Antarctica and land north of the Arctic Circle were not analysed). More than 70 % of the losses are in the semi-arid Middle East and Central Asia (Iran, Iraq, Uzbekistan, Kazakhstan and Afghanistan), due mainly to overuse of irrigation, dam construction and long-term drought. Much of the increase in water occurrence stems from reservoir construction, but climate change may have played a part through increased precipitation and melting of high-altitude snow and ice, as in Tibet.



The [Aral Sea](#) in Uzbekistan and Kazakhstan has suffered dramatic loss of standing and seasonal water cover due to overuse of water for irrigation from the two main rivers, the Amu (Oxus) and Syr, that flow into it. Note the key to the colours that represent different categories of changes in surface water. (Credit: Global Surface Water Explorer)



Many of the lakes in the northern Tibetan Plateau have grown in size during the last 32 years, mainly due to increased precipitation and snow melt. (Credit: Global Surface Water Explorer)

There are limitation to the accuracy of the various categories of change, one being the persistence of cloud cover in humid climates, another being the sometimes haphazard scheduling of Landsat Data capture (in some case that has depended on US Government interest in different areas of the world).

More detail on using remote sensing in exploration for and evaluation of water resources can be found [here](#).