Observations on the Bourne Gutter 2014

Nicholas Pierpoint

The exceptionally high rainfall experienced in southern England in the winter of 2014 has been well documented and described widely in the press. For some in the Thames Valley this was traumatic. However in west Hertfordshire it was interesting to see flow again in the Bourne Gutter, which flows as a consequence of exceptional seasonal rainfall. Observational notes describing the extent of the flow from 4 March to 23 April in 2013 were documented by Pierpoint (2013).

The Bourne Gutter is an occasional tributary ‘winterbourn’, which rises 3km to the west of Berkhamsted and flows into the River Bulbourne at Bourne End (Photo 6), which in turn meets the Gade at Two Waters in Hemel Hempstead. The Bourne Gutter is a ‘woe water’ and is said to flow at times of war or disasters. If this were the case flow should be seen on an annual basis!

This article provides observations of the extent of the flow in 2014, attempts to correlate local rainfall data with corresponding flow periods, and for interest replicates some of the flow measurements documented by Glennie (1960, 1962). Stream discharge data were acquired using a Valeport Electromagnetic Flow Meter at four stations. They were chosen to establish the flow contribution from Mounts Rise and identify if there was any contribution from the swallow-hole at Bottom Farm. The flow rates and stream temperatures are detailed on Fig. 1.

Most of the springs in the Bourne Gutter catchment area are thought to be in the upper reaches of the valley near the contact between the Chalk Rock and the Lewes Nodular Chalk, which have contrasting permeability characteristics. The Chalk Rock is fissured/fractured, whereas the Lewes Nodular Chalk includes the Caburn and Southerham Marls that form barriers to water flow. The British Geological Survey (BGS) Aylesbury Sheet 238 (1923) shows much of the valley bottom from Bourne End to White Hill as valley gravels. Most likely these fluvial deposits are Late Devensian in age (26–12 ka approx.). A synthesis of ideas and contemporary understanding of the hydrology in the area is detailed by Catt (2010, Chapter 9).

In 2012 the summer was wet and limited flow was observed in the Bourne Gutter from March to April 2013. In the winter of 2013/14 heavy rainfall resulted in full stream flow from the Banks Rise (SP 989051, Photo 1) all the way to the confluence with the River Bulbourne at Bourne End (Photo 6). Chalk Rock is shown on the valley floor at Banks Rise on BGS sheet 238, in line with the idea that the springs rise at or near the contact between the Chalk Rock and the Lewes Nodular Chalk.

My observations recorded flow in the Bourne Gutter from 15 February (conversations with local dog walkers suggested it started 12/13th of that month). The initial flow was from Mounts Rise or Culvert Rise (Photos 2 & 3) downstream continuously to the River Bulbourne in Bourne End. By 1 March a large pool at Culvert Rise upstream of White Hill Lane had appeared. In fact it extended 300m and 5-30m wide to within 30-50m of the property boundary at Corner Spring described by Glennie (1960) (SP988051). It extended back through a stand of conifers, which are 40-50 years old, and were not mentioned by Glennie (1960 & 1962). They obscured the Larks Rise spring (SP995553), which was not possible to find.

Flow was continuous from Banks Rise to the Bourne Gutter/Bulbourne confluence in Bourne End on 8 March. The flow was continuous across the meadow downstream of Bottom Farm in contrast with the flow monitored in 2013.

Flow started to wane after 10 April 2014. The source spring
(Banks Rise – Photo 1) had dried up by then and there was no surface flow to Corner Spring. Also the large pool upstream of Culvert Rise/White Hill Lane had significantly diminished in size and depth. By 18 May there was no flow at Bottom Farm across the ‘Buttercup’ Meadow whereas the previous week (May 11th) flow had been continuous from Culvert Rise through to Bourne End. The culvert under the A41 near Vale Farm was partially blocked for a period, which resulted in a large pool upstream of the A41 Motorway. At the rather insignificant confluence with the River Bulbourne at Bourne End, the Bourne Gutter flows through a circular culvert into Mill Leet in the grounds of The Watermill Hotel (Photo 6).

Discharge flow data were acquired at four stations (Fig 1). At Station 4, upstream of Mounts Rise (SP 995057), the flow was 0.0697 m³/sec and below the spring (Station 3) it was 0.0818 m³/sec on the same day, suggesting an increase in discharge of 15% from the spring at Mounts Rise. Photo 3 shows a visible increase in the flow above and below the spring. At Station 2, downstream of the swallow-hole at Bottom Farm, there was a further 16.5% increase in discharge compared with Station 3. This suggests the swallow-hole at Bottom Farm was being fed by another spring. The difference in discharge between the two sites on Buttercup Meadow (Stations 2 and 1) was 6.9% (increase downstream), but this is interpreted as a measure of natural variation in flow, not the result of a further spring contribution.

Glennie (1961) quoted discharge data for sites from above and below Mounts Rise. The figures quoted were 60,000 gals/hr above Mounts Rise and 140,000 gals/hr (0.101 m³/sec) below – implying that 80,000 gals/hr were coming from that spring, which represents a 57% increase in flow, much greater than the 15% increase I measured. The decrease in contribution since 1961 may reflect the increase in groundwater drawdown over the last 50+ years.

To help give some perspective on stream discharge, the rate of 0.1053 m³/sec measured at Station 1 would fill an Olympic 50m (2500 m³) swimming pool in 6.5 hours.

The water temperature upstream of Mounts Rise on 1 May was 8.75°C, but at Mounts Rise itself the water temperature was 9.3°C, with an air temperature of 6°C (Map 1). Glennie (1960) recorded a constant temperature of 49°F (9.6°C from Mounts Rise).

At the Bottom Farm swallow-hole and at the pools at Culvert Rise and Banks Rise, it was common to see small bubbles less than 5 mm across rising through the water. It is suggested these result from air expelled from the unsaturated chalk as the water table rose. The bubbles cannot be biogenic gas as the pools had only existed for a few days. Mallard ducks quickly exploited this new habitat and broods of ducklings have been seen at both Bottom Farm swallow-hole and the pool above White Hill Lane. Herons were also seen hunting for Frogs (successfully).

Two of the principal controls on flow in the Bourne Gutter are the rainfall distribution and the subsurface geology. Monthly rainfall data were provided by Rothamsted Research, Harpenden, which is 11 miles to the east. This is not the nearest weather station but it is likely that major frontal systems provide the critical precipitation that recharges the aquifer and that localised differences in rainfall are not significant. Monthly rainfall values at Rothamsted since 1995 are shown in Fig. 2 and periods of Bourne Gutter flow are shown in red. The period since 2005 is expanded in Fig. 3.

In 2004 a new aerodynamically styled tipping bucket rain gauge (TBR) was installed at Rothamsted Research to replace a manually read cylindrical rain gauge. The team at Rothamsted estimate the new TBR captures 10.5% more rainfall than that of the old cylindrical gauge, but no adjustment has been made to the data pre-2004 to bring it into line with recent values.

Based on his observations (1897 to 1917), John Hopkinson, an active member of the Hertfordshire Natural History Society, suggested that flow in the Bourne Gutter required at least 32 inches of rainfall per year. I believe the relationship is more complex. Further work is required, as several cycles of increasing or decreasing rainfall can be seen.

Flow in the Bourne Gutter is not only dependent on the preceding year’s rainfall, but also when it falls, and, critically, on the aquifer level. This is illustrated in the second rainfall chart (Fig. 3). The rainfall in 2012 was principally in the summer, when there was more vegetation cover, so that the aquifer was not so efficiently recharged. The duration and length of flow...
was shorter in 2013 than that observed in 2014, which followed a wet winter and most likely reflects a higher aquifer baseline. Precipitation over 80mm for a 2-3 month period appears to be critical for flow. Flow in 2007 follows this pattern.

The BGY Aylesbury Sheet (238) is based on field work conducted about a century ago. Even now it would be difficult to delineate the Devensian gravels and sub-crop of the Chalk Rock, so these may not be very accurately portrayed. In addition there is no indication of local dip of the Chalk strata, which could have a bearing on the hydrology, in particular at the Chalk Rock/Lewis Nodular Chalk interface. The geological factors influencing the Bourne flow thus also require further investigation.

There is an intriguing landform at the head of the Bourne Gutter near Banks Rise as the valley axis switches from a NE/SW orientation to a NW/SE direction, leading into Hockeridge Bottom. There was no evidence in 2014 of stream flow from the Hockeridge Bottom Rise (SP983953), which is now under arable cultivation, as opposed to the pasture downstream of Banks Rise (SP989951). It is possible that local water extraction has been responsible for the failure of the Hockeridge Bottom Rise. There are no records of springs or flow in the valley to the SW of Banks Rise, which is a classic asymmetrical Chilterns dry valley, with a steeper north-facing slope and more gentle south-facing slope.

The aim of this article has been to provide an observational snapshot of flow in the Bourne Gutter during the spring of 2014. It highlights some of our knowledge gaps, which include a detailed understanding of the geology and its impact on the hydrology. Superimposed on this is the status of the aquifer prior to periods of heavy rainfall, when the heavy rainfall occurs, and the impact of abstraction. I anticipate the hydrology of the Bourne Gutter valley will receive a lot more attention if, as widely predicted, we experience a wetter climate in future but greater demand on our finite water resources.

Acknowledgments

I wish to thank in particular the support and assistance provided by John Catt both in the field and commenting on this script. I also thank Tony Scott, ECN Site Manager at Rothamsted Research, for providing the rainfall data, and the Geography Department at UCL for the loan of the stream flow meter.

References


Nicholas Pierpoint, contact nicpierpoint@aol.com

A soil quality comparison from agriculture to afforestation in Heartwood Forest

Ashley Lydiate and Chantal V. Helm

Introduction

The benefits of afforestation as mitigation for climate change and the promotion of biologically diverse wildlife communities are becoming increasingly recognised as having global importance (Berthrong et al., 2009; Malhi et al., 2002; Woodland Trust, 2011; Zanchi et al., 2007). As human urban populations and their demands on land and resources continue to grow, however, finding land suitable for afforestation is likely to become more difficult. Jorgensen and Fath (1998) noted that, despite an overall global rise in agricultural land (Benayas et al., 2007), between 1961 and 2002, the UK had the tenth highest continuous abandonment of agricultural land in the world. If this trend were to continue, it would leave a large amount of open land that may be useful for the implementation of afforestation projects. Inherently, however, agricultural methods have numerous, often negative impacts on soil quality (Kibblewhite et al., 2008). As a consequence, the resultant reduction in soil quality, or [the soil’s] capacity to function (Karlen et al., 1997), could be seen as a potential driver for the rises seen in agricultural abandonment. It may be therefore that agricultural land abandoned for these reasons may not be suitable for afforestation (Flinn & Marks, 2007).

On completion, The Woodland Trust’s Heartwood Forest project in Hertfordshire will be the largest new deciduous woodland in England. Some areas have only ceased use as agricultural land in the last couple of years. When fully mature, Heartwood Forest would be classified as a temperate deciduous forest, a habitat with vastly different soil quality requirements from the agricultural communities that were sustained on the land prior to the project’s commencement. Care should be taken to ensure that the soil attributes at Heartwood Forest reflect those found within other established forests of this type within England (Schoenholtz et al., 2000).

Soil quality is a well-researched area of study and an abundance of information can be found on both woodland and agricultural soils. However, there is limited knowledge on how, what and when soil quality changes occur with a transition from agricultural land to woodland over time. As there is a high likelihood of further afforestation projects occurring on abandoned agricultural land in the UK in the future, it is crucial to achieve a robust understanding of what management techniques may need to be employed to ensure healthy woodland growth on and around altered and improved soils, if any.

This study provides analysis of parameters indicative of soil quality; pH (acidity/alkalinity), electrical conductivity (EC), soil organic matter (SOM) as well as earthworm surveys. The combination of these factors will help build an understanding of the soils found in three different habitats in Heartwood Forest, an area of unplanted agricultural land, recently planted woodland and ancient semi-natural woodland (ASNW). Comparisons will be drawn between these habitats to assess how soil quality has changed over time from being arable agricultural land, to how it may be when the woodland is fully established, whilst also providing a starting point for any continued monitoring of the site.

Site description

Heartwood Forest is a 347.22 ha area of ex-agricultural land, formerly known as Hill End Farm, purchased by the Woodland Trust in 2008; situated north of St Albans near Sandridge, within the Green Belt. The aim of the Heartwood Forest project is to create England’s largest new deciduous woodland, with 600,000 trees planted over a ten year period, which, once mature, will provide connections between the areas of existing woodland (ASNW), found on the site and the nearby Nomansland Common to the north-east of the site (Figure 2). The predominant tree species planted include Quercus robur (Pedunculate Oak), Fraxinus excelsior (Ash) and Carpinus betula (Hornbeam), with Acer campestre (Field Maple) and Betula pendula (Silver Birch) also featuring. Woody shrub species planted include Corylus avellana (Hazel), Ilex aquifolium (Holly), Crataegus monogyna (Common Hawthorn) and Viburnum opulus (Guelder Rose) (Woodland Trust, 2012; Smith, 2012).

The previous agricultural aspect of the land displays field patterns suggesting a 300+ year history as grade 3 arable, with likely crops being cereals, oilseed rape,