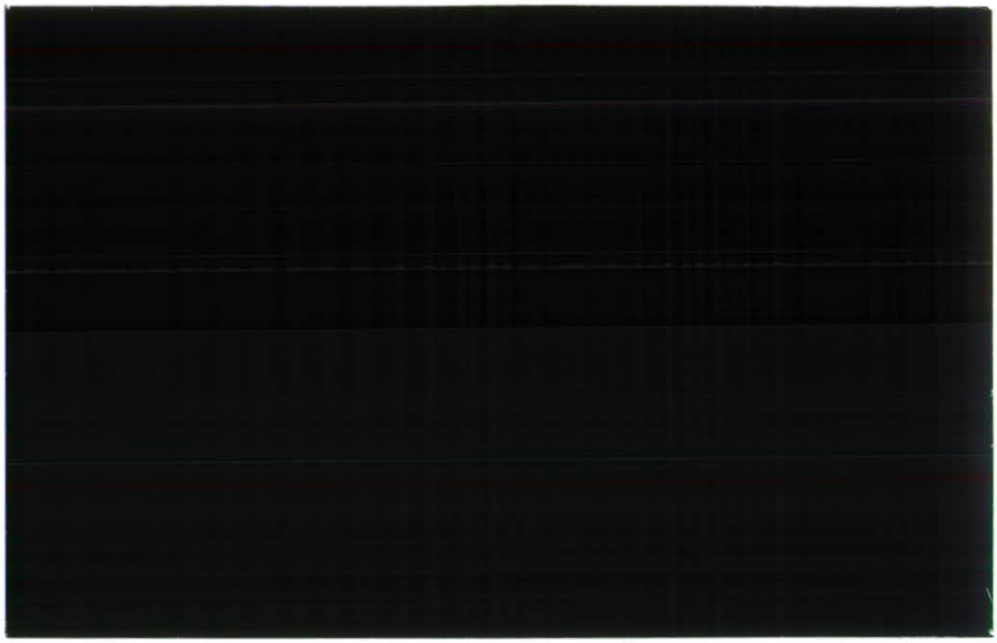
Institute of Hydrology




Natural
Environment
Research
Council

The Significance of Climate Change

For Kent Water Resources

F.M.Law

November 1996

Centre for Ecology and Hydrology
Wallingford
OX10 8BB

The Significance of Climate Change for Kent Water Resources 5.11.96

Frank M Law, NERC Institute of Hydrology,Wallingford

Aim

This note summarises the present state of knowledge on this topic, concentrating on the type of resource system of importance to South East Water and Folkestone and District Water Company.

Background

The key documents are:-
--The Inter-governmental Panel on Climate Change(IPCC) documents published by CUP.
--The DoE Climate Change Impacts Review Group (CCIRG) reports (from HMSO)
--The book by Dr Nigel Arnell (now of Southampton University) published by Wiley in their Institute of Hydrology series,"Global Warming, River Flows and Water Resources"

The IPCC has been through its second series of published deliberations and appears to be winning its case for the global warming being irreversibly underway, with many attendant consequences for regional climate perturbations. The British government supports those conclusions and is encouraging its various arms to take the necessary policy adjustments through to a conclusion. The Environment Agency is making moves to quantify the sensible range of scenarios for river flow change; expectations about groundwater recharge are less well formed but could markedly alter as well.

It is important to keep in mind that some changes are clear cut but many others are speculative at this stage; hence the preference for planning for alternative scenarios.

The Physics of Change

Greenhouse gases, dominated by carbon dioxide, blanket the atmosphere so that its equilibrium temperature around the world is inevitably higher. Stability has not yet been reached but the Global Circulation Models (GCMs) of meteorological research organisations, such as the Hadley Centre of The Met. Office, clearly show the rise continuing into the middle of the next century at least. The growing world population and its industrialisation make this change inescapable unless some countervailing event occurs. Initially predictions of temperature rise were excessively high and were going beyond the observed trend since the Industrial Revolution triggered the upward rise. However it was found that when the cooling effect of sulphate aerosols was added to computer models a convincing calibration was achieved. The big remaining unknown is the frequency and magnitude of huge volcanic ejections of ash and gas into the stratosphere; each of those tends to produce a cooler climate across a hemisphere for say three years, so setting back the underlying warming trend and giving more time to adjust.

Higher average temperatures are being seen primarily through higher night-time minima. Temperature has a close relationship to evaporation, and the latter is known to have been elevated over the last decade or so in the UK. As might be anticipated this has been through winter evaporation rates being increased as true winters have shrunk in length.

There is far less certainty about changes in rainfall, and little agreement exists that measured rainfall regimes are showing climate change signs. This stems in part from the high natural variability of rainfall, masking any small underlying movement of annual or seasonal means. It was already known that long term means were unlikely to be established within 5% even by averaging 30 years of observations; some of my early work on British rainfall statistics showed that it required 70 years of data at a fixed site for a definite estimate of annual variability to emerge that was relevant to reservoir or aquifer systems.

The current wisdom

Under the CCIRG scenario[1]

(a) annual precipitation over the UK as a whole will increased by about 5% from its present level by the third decade of the next century;
(b) winter precipitation will increase everywhere, but more substantially over the southern part of the country;
(c) summer precipitation will decrease over the South, but will increase over the North;
(d) evaporative losses of rainfall will be increased at all times of the year throughout England and Wales, with a consequent reduction in the effective rainfall which in turn determines the extent of run-off and availability of surface water resources;
(e) there would however be a general increase in river flow in winter but a decrease, especially in the South, during summer, with consequences for the seasonal availability of surface water for abstraction for public water supply;
(f) despite heavier winter rainfall, ground water recharge may be reduced because higher evaporative loss and longer-lasting soil moisture deficits in the autumn and early winter would curtail the recharge season.

This CCIRG 1996 scenario, which is for the year 2020, has been worked up with an hydrological rainfall/runoff model for the upper Medway at the Chafford gauging station site[2]. This is shown in Fig 1 attached. It can be seen that the resource picture is gloomy in that all months are expected to have lower flows on average) The summer is effectively one month longer and there is no balancing between months that would make the pumping season longer. Similarly the lower level of excess rainfall that is inherent in the model means that aquifer recharge will be reduced. As river residual flows are unlikely to be dropped in most instances the shortfall all takes place in actual operating yields.As these are now to be worked up on recorded minima[3] it can be seen that if climate change is confirmed the resource level of an existing system will shrink with time.

Unknowns

It could be that a warmer world will involve more energetic storm systems with raised rainfall intensities on fewer days. In such circumstances flow production processes may be more efficient, but at the expense of groundwater recharge.To monitor this will require attention to rain duration frequency diagrams worked up for each decade to compare with the

---

[1]Water Resources Planning and Management: Agenda for Action (Oct 1996) DoE

[2]see Arnell's book p 112

[3]Annex D of the reference in footnote 1

corresponding flow duration curves.

Levels of Service depend on the joint chances of high demand, works outage and low resource states. These have not been tackled by modern statistical methods yet. This is needed because there is evidence that present consumers wish to raise their demands above typical levels early in a season that subsequently proves to remain dry for a prolonged period.

Warmer weather means warmer rivers with enhanced stress on fish life if low flow seasons are severe as well. It is not known whether fish can gradually adjust to a new regime on the timescale envisaged.

The regional emphasis from GCMs to date has only been able to differentiate between Scotland and England, and even so is only marginally justifiable given the poor calibration of daily rainfall between gridded meteorological models and observed reality. However the joint commissioning[4] by EA and UKWIR of regional river flow adjustment parameters should lead to improved awareness of potential change by the end of 1997.

[4]from Dr N.W. Arnell (Southampton University) and Mr N.S.Reynard (IH)

Fig 1 Monthly mean runoff expected by 2020 under CCIRG scenario