Ecohydrology & Hydrobiology 14 (2014) 21–32

Contents lists available at ScienceDirect

Ecohydrology & Hydrobiology

journal homepage: www.elsevier.com/locate/ecohyd

Discussion Article

Models from ecohydrology and hydrobiology can inform our human future

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ARTICLE INFO

Article history:
Received 2 September 2013
Received in revised form 28 December 2013
Accepted 15 January 2014
Available online 7 February 2014

Keywords:
Biome
Anthrome
Reservoir
Alternative states
Restoration

ABSTRACT

Freshwater problems link a future 'perfect storm' of climate change, self-inflicted problems of health and economics in the developed world, poverty, overpopulation, and disease in the developing world, and, most fundamentally, conversion of most former land biomes to anthromes: human-dominated, agricultural and urban systems, with consequent diminution of regulatory ecosystem services. Biological processes regulate the compositions of the ocean and atmosphere, such that a band of equable temperatures has prevailed for millions of years. Biomes self-regulate through natural selection of their components; no comparable engineered system is tested so rigorously. Anthromes offer provisioning and cultural services but almost none of the fundamental regulatory services that biomes provide, and then only to the extent that biomes underpin them.

Engineering of biomes to multiple-use anthromes has steadily eroded their long-term value in favour of short-term wealth creation. When they have deteriorated, we have converted more biome to compensate. This can never be sustainable and the remaining area of biome is inadequate to provide sustained regulatory services. As well as our limiting carbon emissions severely to mitigate our problems, large areas of present anthromes will need to be restored to natural biomes, the human footprint confined to much smaller areas, and our engineering talents devoted to making human societies thrive in the latter. We are a clever species and can solve these problems, but only if the selfish interests of the rich and powerful in particular, and if the self-interest of our minds, itself paradoxically determined by natural selection, can be curbed.

1. Introduction

Ecohydrology frequently uses scenarios and models to summarise, manipulate and extend sets of data so as to determine current management of rivers and lakes, or to anticipate future scenarios of rainfall or abstraction. One frequent scenario concerns the effects of damming and the creation of reservoirs. Experience of the social and economic aspects of dam creation in the past can also be modelled to minimise, though rarely avoid, problems of loss of floodplain agriculture, health, conservation and fisheries in current and future schemes (Fujikura and Nakayama, 2009; Scudder et al., 2005; World Commission on Dams, 2000). There is, however, another aspect — that of approach and attitude on the part of the dam promoters — which might be a telling model in the wider sphere of dealing with the complex of global environmental problems, and associated cultural damage, that will intensify in the rest of this century and beyond.

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http://dx.doi.org/10.1016/j.ecohyd.2014.01.001

This paper illustrates how such promotion of major dam schemes provides a parallel for how global problems are currently being perceived, and the flaws in that approach. It suggests that current disregard for an alternative approach, which takes into account the operation of ecosystem processes, is a major error and illustrates how such processes must be harnessed through restoration of substantial areas of land, now under agriculture, to near-natural biomes to balance remaining carbon emissions. Using another model to which hydrobiology has contributed a great deal, that of alternative states in shallow lake and other ecosystems, it then analyses why our societies have disregarded ecosystem processes in solving global problems, and finally it concludes that a comprehensive strategy embracing biome restoration, reform of food production and supply, and changes in the balance of power will be essential to guarantee a civilised human future.

2. Reservoir schemes

The industrial expansion of the United Kingdom, in the early 19th century, brought workers into the cities, and accommodated them in poor housing that lacked adequate sanitation and water supply (Engels, 1845). In Manchester, UK, private companies took water from the polluted River Medlock to small local holding tanks and redistributed it, untreated, to households, but covered only a quarter of the city and charged high prices. The water was foul because the sanitation system was equally primitive and in 1832 there was a devastating cholera outbreak in the city slums. The Manchester Corporation called in Frederick LaTrobe Bateman, a young engineer, who devised one of the first major water supply schemes as a chain of reservoirs in Longendale, along the River Etherow, 20 km to the east of the city (Hassan and Wilson, 1979). There the water flowed off the uplands, was copious and much purer. It took from 1846 to 1877 to complete the scheme, at the start of which Bateman calculated that the supply, rated at 20 gallons per person per day (33 $m^3 a^{-1}$ per person) would be adequate. The steady increase in number of people and of water closets meant that this soon became an underestimate, and bigger schemes would be needed. A comprehensive analysis of the water supply issues of Manchester is given in Ritvo (2009), from which this précis is summarised.

The Reform Act of 1832 had changed the nature of the British Parliament, giving more power to a wider range, and greater number, of democratically elected Members of Parliament, and of elected councillors of City Corporations. The booming economy, based in Manchester on cotton spinning and trade, had brought money and influence. By the 1870s a monumental Town Hall reflected the City Corporation's confidence as its Waterworks Committee sought new water sources in the Cumbrian Lake District, 160 km to the north.

The Committee's surveyors were covert in their explorations, for it was intended to buy an entire catchment and lake, and they did not wish to inflate land prices. They selected Thirlmere, a deep but small lake, set in a much larger valley, with a rock-set gorge at the outflow. It could be dammed to create a reservoir 15 m deeper and of much greater surface area than the natural lake. There was little doubt in the Corporation that Manchester had a right to this water; there was a great need, and a need, it assumed, generated a right. But when Manchester's plans became public, there was an unexpected storm of objection. It did not come from the few local landowners, who held out for high prices for their property, but were eventually willing to sell. Objection came from a large number of people who did not live in the valley but valued it for its landscape, amenity, and association with the lake poets, William Wordsworth, Samuel Taylor Coleridge and Thomas Southey. These and a variety of painters, including J.M.W. Turner, perhaps the most famous English landscape artist, had popularised the Lake District by their works (for example, Wordsworth, 1835) and turned what Daniel Defoe, a century earlier (Defoe, 1726), had described as '*eminent only for being the wildest, most barren and frightful of any I have passed over in England, or even in Wales itself*', into a cherished land, famous for its beauty and wildlife.

The Thirlmere Defence Association was formed, made up of prominent artists, educationists and intellectuals, not least the well-known art critic and social philosopher John Ruskin, and people such as H.D. Rawnsley and Octavia Hill, who eventually came to found the Open Spaces Defence Society, and eventually the National Trust, now the biggest land owner in the Lake District and a force reckoned almost entirely for good in contemporary Britain. The Thirlmere Defence Association, and the local Members of Parliament for the Lake District, were influential enough to block the Manchester Corporation Water Bill in Parliament in 1878 and force a Parliamentary Committee of Enquiry. There were not only objections to the effect of the reservoir in changing the nature of the valley, but also protests from towns along the pipeline that would bring the water to Manchester. These were experiencing the effects of manuring and fertilising of the land, by an equally confident agricultural industry, on their existing local water supplies, and wished also to tap into the better supply from the Lake District.

The Committee of Enquiry inevitably found for the Manchester Corporation. It insisted on some tree planting to mitigate the effects of the reservoir in drowning existing woodlands, and instructed that the intervening towns should be supplied also with the water, but the scheme was seen to be essential to Manchester. However, a dent had been made in the somewhat presumptuous and self-interested attitudes of the economics-driven City Corporation, and an influential environmental movement had been born. Nonetheless, as the new owner, the City Corporation was domineering and unsympathetic. It felled existing woodlands and replaced them with exotic conifer plantations that many considered inappropriate and ugly, designed as they were to produce future revenue as much as to minimise soil erosion and sedimentation in the basin, and it restricted access to walkers and anglers in the area.

Other City Councils, indeed even Manchester Corporation, learned a little, but not much, from the experience, and the opposition they received to later reservoir schemes. But fundamental approaches and attitudes changed little. In the 1960s, the Liverpool City Council