WATER INFORMATICS SCIENCE & ENGINEERING
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Assessing risk to water security in complex coupled catchment-reservoir systems

Abstract

Surface-water reservoirs are a critical component in many water supply systems. Climate change is expected to increase the variability of both precipitation and temperature regimes over the rest of the 21st Century. Interactions between climate and land-use changes in complex catchment-reservoir systems are broadly unknown. The biogeochemical status of drinking-water supply reservoirs is closely linked with the quantity and quality of runoff from contributing catchments, as well as the internal processes of the reservoir itself.

This project aims to achieve a new dynamic coupling of a catchment runoff model and a lake biogeochemical model, in order to quantify the risk to water security, under a range of possible future scenarios. It will focus particularly on several drinking-water supply reservoirs in the west of England and Wales, and link with ongoing efforts at University of Bath to understand lake biogeochemical systems using hydrological modelling, emphasising land-use change under uncertain global warming scenarios.

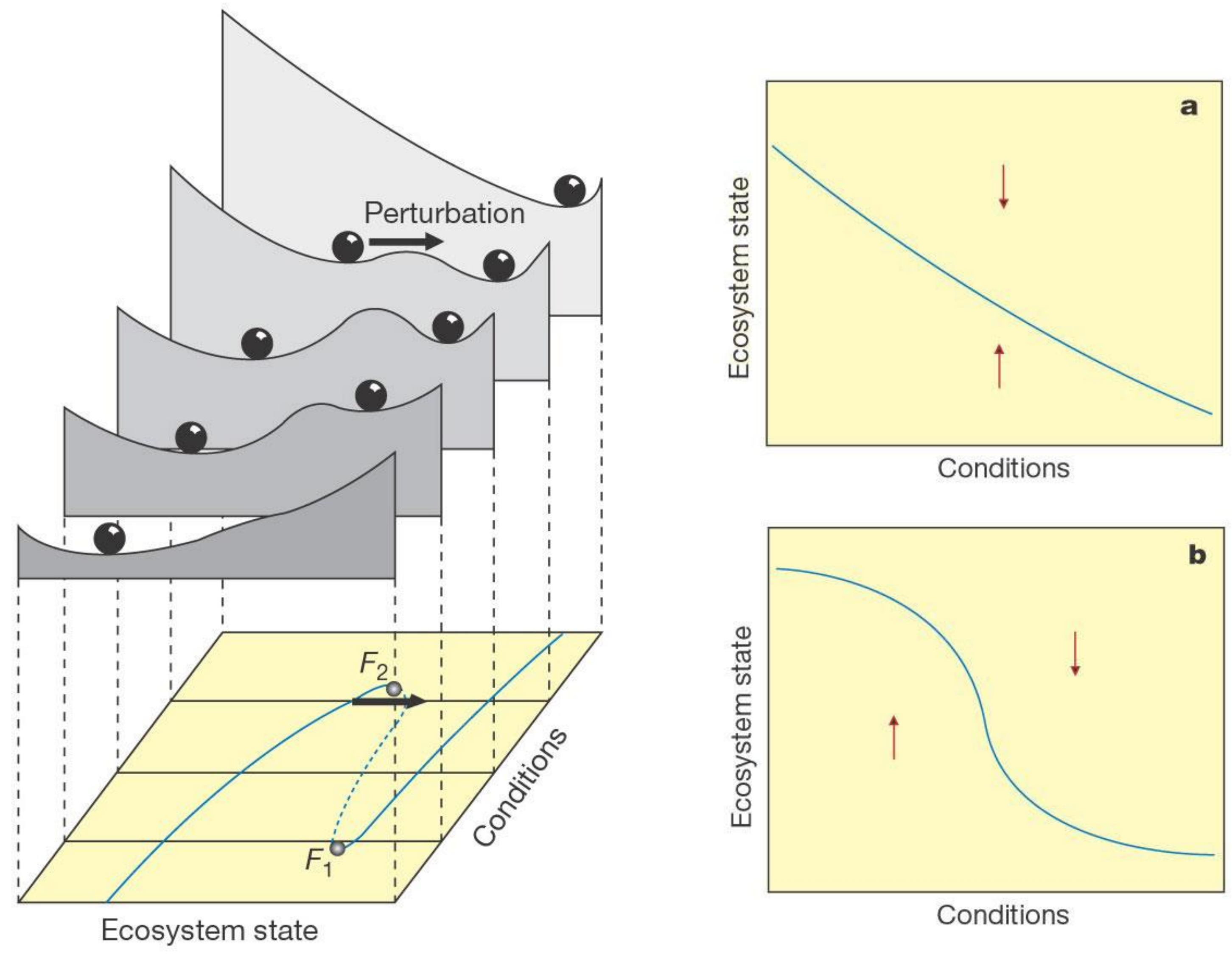
Blagdon Reservoir [1]

Introduction

In recent years, security of both the quantity and quality of drinking-water supply has become a global concern. The risks of future challenges to the UK water sector are serious. This is further complicated by climate change, population growth, and land-use change pressure, which are difficult to both predict and quantify. Increasingly vital to understanding hydrological responses to changing external pressures is knowledge of the relationships and extent of interaction that exists within more complex systems.

Water supply reservoirs are a significant source of abstraction for UK water companies, and are therefore on of the key components of the water supply network at risk under changing future conditions. Therefore, there is significant benefit in quantifying and understanding that risk, and how it changes under a range of possible conditions Within complex environmental systems such as these, there may be several alternate stable operating structures. Movement between these stable regimes is often seen after extreme events. However, in some systems, continuous parameter change, or variation around average parameter values can lead to sudden regime shifts due to the complexity of parameter interaction[2].

Human-derived environmental changes and pressure on such systems, such as agricultural land-use change and urbanisation, can significantly alter the resilience of the system to regime shifts by lowering critical thresholds[3]. Drinking water supply reservoirs can be severely affected by undesirable regime shifts, often affecting water quality and quantity[4].



Conceptual visualisation of regime shifts *(Adapted from [3])*

Aims:

- Develop a dynamic coupling of two models to represent catchment runoff and reservoir biogeochemistry to quantify risk to water security
- Assess coupled whole-system model output using developed future scenarios of land-use and climate change

Objectives:

- Acquire long term datasets on upstream hydrological data and reservoir biogeochemistry
- Successfully couple catchment rainfall-runoff model and reservoir biogeochemical model
- Collect any missing data or process knowledge 'gaps' using field work
- Apply the whole-system model to several case studies using developed future scenarios of changing land-use and climate

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[1] http://www.milbourne.net/HOSTEDSITES/blagdonlakebirds/Assets/myimages/1DS47160%20Blagdon%20Lake%20June%202015.JPG [12/06/17]
[2] Andersen, T., Carstensen, J., Hernández-García, E. & Duarte, C. M. (2009) 'Ecological thresholds and regime shifts: approaches to identification'. Trends in Ecology & Evolution **24,** 49–57).
[3] Scheffer, M. & Carpenter, S. R. (2003) 'Catastrophic regime shifts in ecosystems: linking theory to observation'. Trends in Ecology & Evolution 18, 648–656
[4] Fukushima, T. & Arai, H. (2015) 'Regime shifts observed in Lake Kasumigaura, a large shallow lake in Japan: Analysis of a 40-year limnological record'. Lakes Reserv Res Manage 20, 54–68

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