READING 2050: MANAGING FLOOD RISK

Dr Joanna Clark
Associate Professor in Environmental Science
Co-Director, Loddon Observatory

Prof Hannah Cloke, Dr Jess Neumann, Louise Arnal (and others...)

Copyright University of Reading
OUTLINE

• What causes flooding?

• What can we do to manage the flood risk?

• Flood forecasting and preparedness
  • Examples from IMPREX project

• Using nature-based solutions to reduce flood risk
  • Options for urban green spaces (including your garden!)
  • Catchment wide options (LANDWISE project)
WHAT CAUSES FLOODING?
FLOOD IMPACTS

Pangbourne, Jan 2014

Didcot Parkway, Sep 2016
@nickhaisman

• Danger to life and property
• Damage, destruction, disruption
• Economic & psychological impacts

Courtesy of Dr Geoff Parkin

LIMITLESS POTENTIAL | LIMITLESS OPPORTUNITIES | LIMITLESS IMPACT
Berkshire floods: 21 pictures which tell the story of the 2014 flooding

This time last year, parts of Reading and Wokingham were underwater. We've picked out some of the most vivid photos which show the scale of the floods.
Secondary school in Earley closed due to flash flooding

The closure comes after flash flooding in parts of Berkshire

By James Aldridge, Live News Journalist
06:41, 19 Jul 2017 | UPDATED 15:34, 19 Jul 2017
MAIN TYPES OF FLOODING IN WEST THAMES

• Flooding from surface runoff from intense rainfall

• Flooding when the river(s) overflow their banks

• Flooding when groundwater rises
FLOOD RISK FROM RIVERS

flood-warning-information.service.gov.uk/long-term-flood-risk/
FLOOD RISK FROM SURFACE RUNOFF

flood-warning-information.service.gov.uk/long-term-flood-risk/
TYPES OF RUNOFF

- **Infiltration excess surface runoff**
- **Saturation excess surface runoff**

Infiltration excess surface runoff: Rainfall exceeds the capacity of the soil to absorb and retain water, causing excess water to run off the surface.

Saturation excess surface runoff: When the soil is saturated, any additional rainfall cannot be absorbed by the soil and runs off as surface runoff.
Rain/snow/hail

Contributing area

Soil & ground water conditions

Land surface properties
LIMITLESS POTENTIAL | LIMITLESS OPPORTUNITIES | LIMITLESS IMPACT

12

READING

Carbonate Mudstone Sandstone

Generalised Geology

OS basemap (2016) and BGS hydrogeology (2012) sourced from Edina Digimap
SOIL PROFILES

Shallow lithomorphic soil over Carbonate

Surface water gleys over Mudstones

(Ap) Very dark greyish brown, moderately stony humose silty clay loam; strong fine granular or angular blocky structure; very calcareous.

(Cu) Fragmented white chalk with dark brown soil between chalk and flint fragments.

(Cr) Weakly bedded chalk with flint nodules.

(Apg) Dark greyish brown, mottled, stoneless or slightly stony silty clay loam or clay loam.

(Eg) Greyish brown, mottled, slightly stony clay loam; moderate medium and fine subangular blocky structure.

(2Btg) Strong brown with many grey mottles, stoneless or slightly stony clay; strong medium angular blocky structure.

(BCg) Grey with many ochreous mottles, stoneless clay; strong coarse prismatic structure.

http://www.landis.org.uk
RAINFALL @ READING UNIVERSITY

Total Annual Rainfall

Maximum Daily Rainfall
Average river flow by year from 1952-2015 at Swallowfield

Johnathan Cocks, Part 3 BSc Geography
UKCP09 PROJECTIONS: THAMES

Summer Precipitation

- 2020s: 50% probability level: central estimate
- 2050s: 50% probability level: central estimate
- 2080s: 50% probability level: central estimate

Winter Precipitation

- 2020s: 50% probability level: central estimate
- 2050s: 50% probability level: central estimate
- 2080s: 50% probability level: central estimate

http://ukclimateprojections.metoffice.gov.uk
WHAT CAN WE DO TO MANAGE THE FLOOD RISK?
At School Street School, stormwater is managed to protect nearby Willow Brook. The porous pavement, rain gardens, dry well, and rain barrel capture water from rain and snowmelt and allow it to infiltrate into the soil.
FLOOD FORECASTING & PREPAREDNESS
Prof Hannah Cloke  Dr Jess Neumann  Louise Arnal

@hancloke  @Jess_n1  @ArnalLouise
THAMES BARRIER, River Thames, London, UK

Environment Agency

Use of ensemble forecasting led to increased preparedness and a reduction in flood risk in winter 2013/14

HYDROLOGICAL ENSEMBLES OF...

- soil moisture, runoff, river flow (including floods), groundwater, snow, reservoir inflows/volumes...
PROBABILITYSTIC FLOOD FORECASTS

Ensemble forecast: better decision making

> Which scenarios are most likely

> also what ‘worst case’ could be.

- awareness of flood up to 8 days before the event
- subsequent forecasts provide increasing insight into the range of possible flood conditions

Ensemble forecasts and warnings can only reach their full potential if they are understood and acted upon by the person receiving

Communication of uncertainty

Coproduction of warning systems


Wetterhall F, Pappenberger F, Cloke HL et al + 30 authors (2013) Forecasters priorities for improving probabilistic flood forecasts, Hydrology and Earth System Sciences, 17, 4389-4399
Acknowledgement

IMPREX is a research project supported by the European Commission under the Horizon 2020 Framework Programme
Grant Agreement No 641811

PATHWAYS TO RUNNING A FLOOD FORECASTING CENTRE: AN ADVENTURE GAME!

AIM OF THE GAME
To understand this process through real life decisions & in a fun environment

Information
- e.g. forecast, expert advice

Consequences
- positive vs. negative

Decision
- e.g. flood defences
GAME SETUP

• You are hired as head of a flood forecasting centre & your task is to protect a city from floods
• You have to manage 2 teams:

  the forecasters can:
  • show you the latest forecast
  • improve the forecast

  the flood response team can:
  • tell you what the situation on the ground is
  • install temporary flood defences
  • evacuate the population

• You have an initial budget & popularity level and are responsible for all actions taken

Louise Arnal – l.l.s.arnal@pgr.reading.ac.uk; louise.arnal@ecmwf.int
GAME RESULTS & WHERE TO PLAY IT!

• Players’ decisions based on forecast rather than expert advice
• Players used forecast with intuition (rather than looking at statistics of the forecast)

Ever wondered what it’s like to run a flood forecasting centre? Try it yourself!

At: [https://goo.gl/bfZISB](https://goo.gl/bfZISB)

*doesn’t work on phones

Acknowledgement

IMPREX is a research project supported by the European Commission under the Horizon 2020 Framework Programme
Grant Agreement No 641811
THE IMPREX PROJECT

- Sectors – flood risk assessment, hydropower, transport, urban water, agriculture and economy

- Case study – Thames Basin, UK
- Compound flooding
- Hydro-meteorological predictability
- Catchment characteristics
- Seasonal forecasting

"LONGER RANGE HYDROLOGICAL FORECASTS FOR STAKEHOLDERS AND SOCIETY, TO GIVE AN INDICATION OF POSSIBLE FLOOD EVENTS SEVERAL MONTHS AHEAD."

Jess Neumann, University of Reading
WHAT WE’RE LOOKING AT

- **Compound flooding**: Attributable to multiple sources due to the co-occurrence of high rainfall, high river discharge and high groundwater levels.
- 2013-14 floods
- West Thames catchments
- Do improved seasonal meteorological forecasts lead to more skilful seasonal flood forecasts?
Compound floods (fluvial, pluvial and groundwater) – Thames, UK

“The co-occurrence of high rainfall, high streamflow and high groundwater discharge”

Seasonal (7 month) outputs…
TAKE HOME MESSAGES

• Meteorological forcing is important in groundwater-driven systems

• The tropics were important in the development of the 2013-14 extreme conditions

• Catchments responded differently due to their characteristics

• Permeable lithology and antecedent conditions were important for skilfully forecasting groundwater levels
THE FUTURE?

Flood alert with 6 weeks lead time
Seasonal Hydrological Forecasting can provide an effective early warning of potential high-impact events, allowing for better preparedness.
USING-NATURE BASED SOLUTIONS TO REDUCE FLOOD RISK
WHAT ARE NATURE-BASED SOLUTIONS FOR FLOOD RISK?
NFM OPTIONS

Option 1:
Increase infiltration and below ground water storage

Option 2:
Slow the flow of water from hillslope to river

Option 3:
Slow and store water on floodplains
WHAT CAN YOU DO ON YOUR DRIVE?
WHAT CAN YOU DO IN YOUR GARDEN?
WHAT CAN WE DO IN OUR URBAN AREAS?
LANDWISE: LAND Management in lowland catchments for Integrated flood risk reduction

NERC Strategic Programme: Evaluating the Effectiveness of Natural Flood Management

Funding: £1.25m NERC + £400k in kind + £300k from UoR

4 year project (2017-2020)
LANDWISE Team

What can we do to make the bucket larger and keep it empty?
TESTING A THEORETICAL FRAMEWORK

• Dadson et al (2017) propose a conceptual framework for NFM measures
LOCATION

Scale
Fields (everywhere)

Catchments:
Upper Thames
Pang
Loddon

River Basin:
Upstream Oxford
Upstream Maidenhead
OB 1: LOCAL KNOWLEDGE & SCENARIOS

- Collate available data
- Calculate the catchment flood mitigation capacity needed
- Local knowledge about land management
- Local knowledge about current and future land management scenarios
OB2: FIELD DATA

- Collate available data
- Broad scale survey of basic soil surface properties
- Detailed survey of soil surface and subsurface properties
- Data to support remote sensing and modelling work
OB3: REMOTE SENSING

- Detailed site surveys below ground and above (drones)
- Catchment wide satellite data
- Focus on soil moisture and vegetation properties that affect evapotranspiration
OB4: MODELLING

• Integrate land surface, catchment rainfall-runoff, groundwater and river channel models
• Start with the Pang, move to Upper Thames and Loddon, then wider river basin
• Sensitivity analysis
• Run locally developed scenarios
OB5: VISUALISE & EXPLORE

- Develop easy to use web-based applications to help people use data and knowledge to inform NFM planning decisions.
What is LANDWISE?

LANDWISE is one of three projects funded by the Natural Environment Research Council evaluating the effectiveness of Natural Flood Management programme. LANDWISE seeks to examine how well natural land-based measures can be used to reduce the risk of flooding for communities.
SUMMARY: MANAGING FLOOD RISK

• Three main types of flooding in West Thames area: surface water, river and groundwater
• Where and when flooding occurs depends upon interaction between timing and duration of rain/snow/hail, land surface properties, soil and groundwater conditions, contributing area
  • Infiltration excess runoff caused by intense rainfall
  • Saturation excess runoff caused by prolonged rainfall
• What can we do to manage flood risk?
  • Be prepared. Flood forecasting, especially seasonal forecasting
  • Reduce the area of impervious surfaces in urban areas
  • Nature-based solution to utilised capacity of land to store water and slow the flow in urban areas AND upstream