

# **Understanding sediment as the catchment level: A risk based approach**

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## Key drivers for this work

1. Water Framework Directive (WFD)
  - Requires holistic management of water
2. UK failing the WFD
  - Currently 18% of surface water bodies reach 'good' ecological status
  - Large percentage of failures till unknown
3. Wensum is SSSI and is failing WFD
  - Main water course failing to meet 'good' status
4. Sediment big issue
  - Key issue with Wensum failures is diffuse sediment transport
  - Estimated that 75% of sediment in Wensum come from agriculture

## Aim & Objectives

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### Aim

To assess sediment transport at the catchment scale using a risk based approach

### Objectives

1. Research s-p-r linkages of sediment at the catchment scale, including factors that will effect the significance of the linkages
2. Produce a conceptual model of the s-p-r linkages aimed at engaging multiple stakeholders, including regulators, farmers and the public
3. Using the conceptual model as a guide, assess what the key s-p-r linkages are in the Wensum catchment
4. Suggest the best mitigation measures available to the Wensum catchment for reducing sediment transport

## Risk Management and Source-Pathway-Receptor

- The WFD requires member states to assess the risk of water bodies failing the objectives in river basin management plans (RBMPs)
- Four stages of Risk management
  - 1. Problem formation
  - 2. Risk Assessment
  - 3. Selection of management techniques
  - 4. Implementation of management techniques
- Source-pathway-receptor (s-p-r) modelling is used in the first stage in order to assess possible exposure routes for risk
- Principle of s-p-r
  - In order for there to be risk, there must be a source (pollutant or cause of harm), receptor (human, environment etc) and a pathway (exposure route)

## Objective 1.

Research s-p-r linkages of sediment at the catchment scale, including factors that will effect the significance of the linkages

- Source definition: The physical origin, location and type (I.e. road bank sediment)
  - This is useful as it aids management
  - Certain land used produce specific type of sediment that may harm a particular receptors
- Pathway definition: The physical delivery process that transports the source to the receptor
- Receptor definition: The river ecosystem as a whole
  - Receptors will be site specific dependent on species available and the type of sediment
  - The consequences of sediment reaching rivers is discussed

## Sources

### Five main management sectors

#### Natural

Flood plain erosion  
Channel bed resuspension  
Channel bank erosion  
Woodland top soil  
Mass movement  
Wind erosion  
Cliff erosion

#### Agricultural

Arable top soil  
Arable sub surface soil  
Livestock poaching  
Slurry storage

#### Urban

Urban top soil  
Construction sediment  
Road dust and top soil

#### Mining

Geological mines  
In stream mining / dredging

#### Waste

Septic tanks  
Sewage Treatment works  
Land fill sediment

# Pathways

## Surface run off

- Flood plain erosion
- Channel bank erosion
- Woodland topsoil
- Arable topsoil
- Cattle poaching
- Slurry
- Urban topsoil
- Construction sediment

## Sub surface drainage

- Arable sub surface soil

## Road networks

- Road dust and topsoil

## Atmospheric deposition

- Top soils
- Wind erosion
- Sand and dust



## Receptors / Consequences

### Turbidity

- Reduces photosynthesis and primary production

### Eutrophication

- High N + P create algal blooms
- Reduce light penetration and kill aquatic organisms

### Dissolved Oxygen Content (DOC)

- Sediment high in organic matter is broken down by aerobic organisms that use up oxygen in water
- Effects fish and other organisms reliant on oxygen

### Bedform

- Covers river bed with sediment which takes up space that gravel spawning fish would use
- If it occurs after spawning, can cover eggs and reduce oxygen reaching them

### Flood risk

# Stressors

## Terrain

- Steeper slopes = Increased run off and risk of rills and gullies

## Geology and soil type

- Sandy soils less likely to erode than clay loams

## Land use

- Will effect the chemical fingerprint (N + P + heavy metals)

## Weather

- 90% of sediment is transported 10% of the time

## Farming practises

- Crops types, stocking rates and fertilizer use will all effect erosion rates and chemical fingerprint

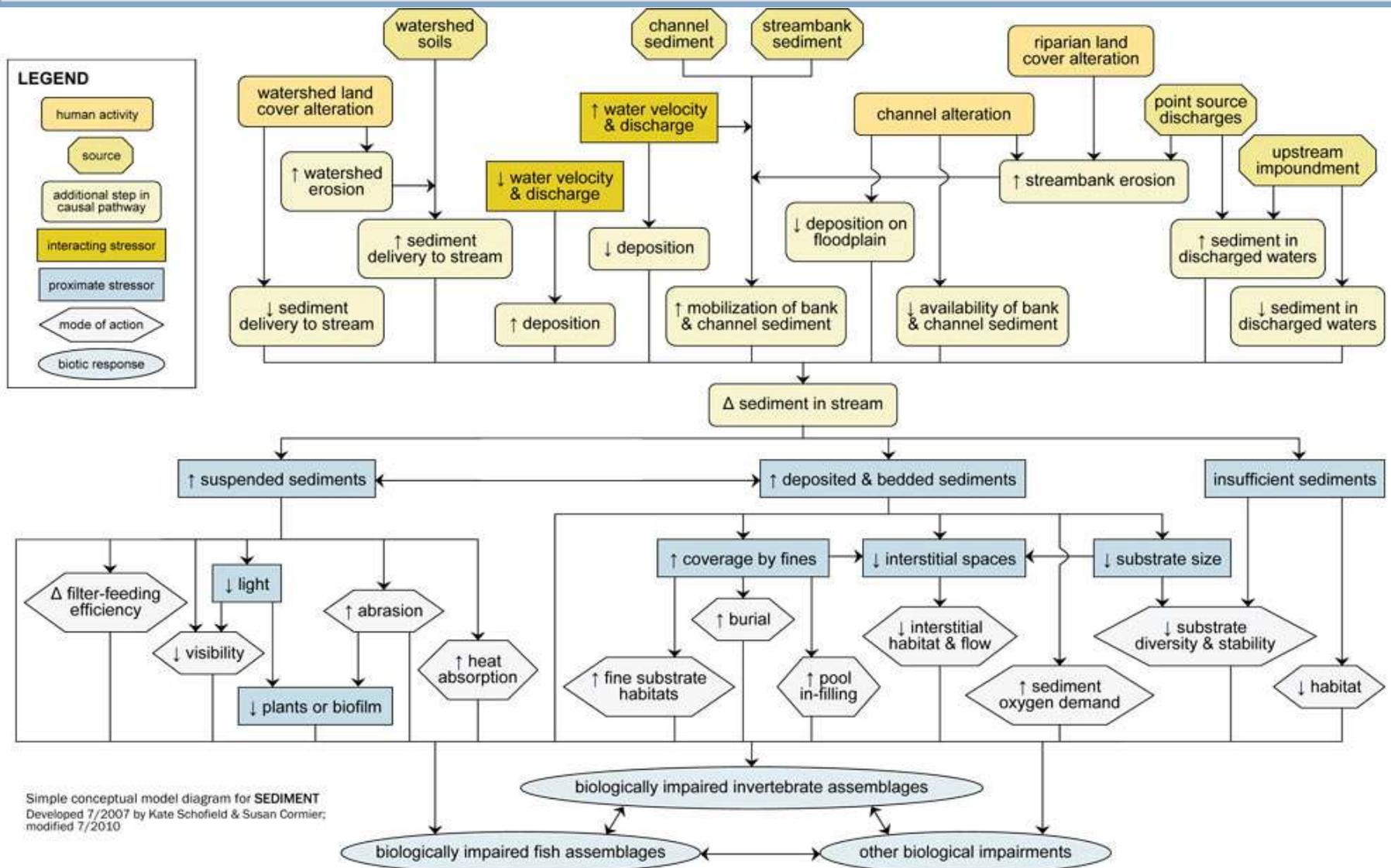
## History

- Logging - reduces soil stability
- Contamination - 'sleeping' sediment can be a long term risk factor

## Objective 2.

- Produce a conceptual model of the s-p-r linkages aimed at engaging multiple stakeholders, including regulators, farmers and the public
  1. Facilitate communication
  2. Integrate knowledge across disciplines
  3. Increase understanding
  4. Identify knowledge gaps
  5. Facilitate participation
- Important to engage stakeholders as sediment is a diffuse pollutant
- Many of the biggest diffuse polluters (farmers) have voluntary mitigation schemes that require co-operation so good to aid understanding and engagement

# Too complex



Simple conceptual model diagram for **SEDIMENT**  
Developed 7/2007 by Kate Schofield & Susan Cormier;  
modified 7/2010

# S-p-r conceptual model

- Key**
- Surface run off
  - Sub surface drainage
  - Mass movement
  - Atmospheric deposition
  - Road run off
  - Deposition & resuspension
  - Bank erosion
  - Sediment build up
  - Algal bloom / eutrophication
  - Turbidity
  - DOC Dissolved organic compounds
  - $\text{NH}_4^+$  Ammonia
  - N+P Nitrogen & Phosphorous
  - Pb Heavy metals



## Legend

### 1. What is the terrain in the catchment

- a) Steep slopes
- b) Undulating hills
- c) Flat

### 2. What is the soil type

- a) Sandy
- b) Clay
- c) Loam

### 3. What is the predominant land use in your catchment?

- a) Agriculture
- b) Woodland
- c) Urban

### 4. If the catchment is agricultural, what type of farming is present?

- a) Arable farming
- b) Livestock

### 5. Weather Events

- a) Heavy rain

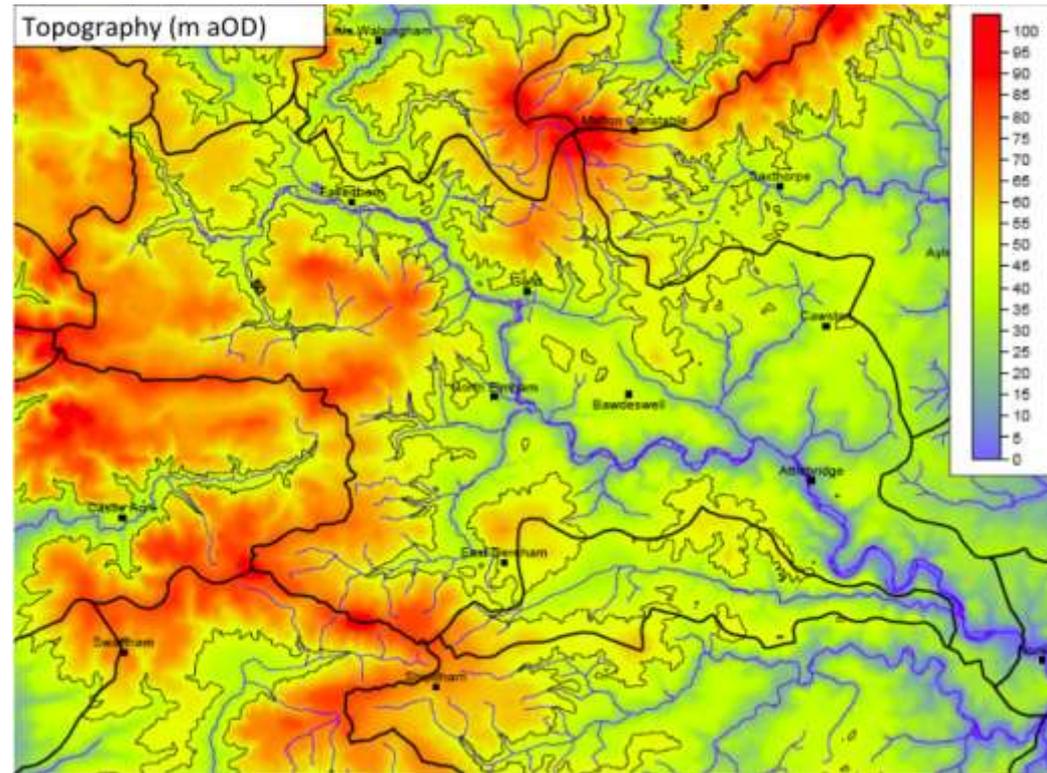
### 6. What is the history of the area?

- a) Previously wooded / logging area
- b) Area of heavy industry in the past

## **Applying this to the Wensum**

# Terrain

- Relatively low lying
- Mini catchment ranges from 50 - 30 AOD
- Mass movement (landslides) can be disregarded
- Surface run off will be more important on slopes and valley sides
- Other pathways may play an important role



## Land use

Predominantly agricultural

- 62.6% is arable
- 20% is livestock grazing

Urban is very small

- >10%

• Road Networks can be an important source

• Sediment will be higher is N + P

• Agriculture will be a key source but will depend on the pathway: available



# Soil, weather and history

## Soil type

- River valley loams overly clay = low permeability + increase risk of surface run off
- Valley slopes sandy loams = higher permeability + very fertile

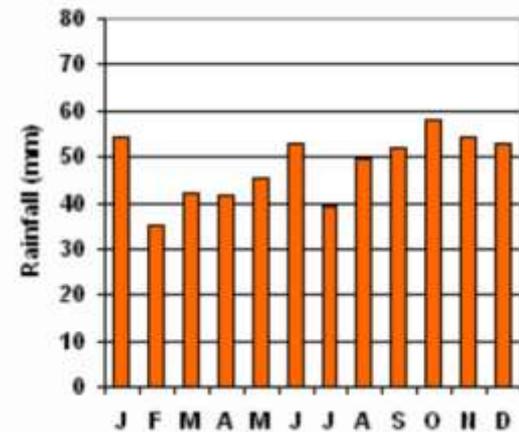
## Weather

- Relatively dry compared with other areas of the country but less seasonal variation

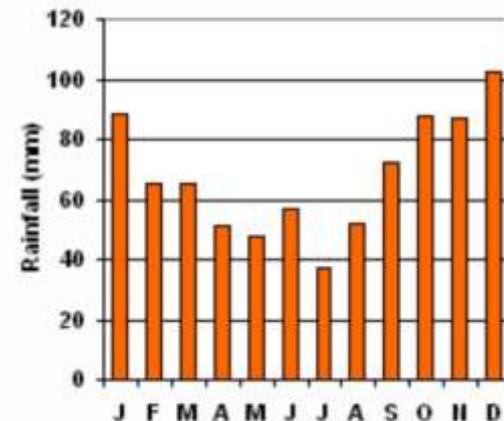
## History

- Originally woodland but since the stone age - increased open land for crop cultivation

Mean monthly rainfall (1971-2000)  
at Writtle (32 metres amsl)



Mean monthly rainfall (1971-2000)  
at Hurn (10 metres amsl)



## Farming practises

### Arable

- Predominantly cereal crops though a move towards oil seed rape and sugar beet in recent years
- Around 80% of Salle farm (mini catchment A) is drained by sub surface drainage
- Indicator of other farms in the catchment
- Sub surface drainage will be an important pathway

### Livestock

- Often grazed on soils too wet for arable and so are easily poached
- Evidence of cattle poaching around river banks
- Exact stocking rate not know but will effect the amount of poaching
- Surface run off will be key pathway for this sediment

## Key s-p-r linkages in the Wensum

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1. Arable soil - Sub surface drainage - river
2. Road network - surface run off - river
3. Livestock sediment - surface run off - river
4. Channel bank erosion - surface run off - river

## Possible mitigation measures

### Catchment Sensitive Farming

1. Lined biobeds (off-set or drive-over)
2. Yard works for clean and dirty water separation
3. Roofing of manure storage and livestock gathering areas
4. Sediment ponds and traps
5. Livestock and farm machinery tracks
6. Cross drains on or in farm tracks
7. Resurfacing of gateways
8. Relocation of gates
9. Pesticide sprayer loading and wash-down areas

### Entry Level Stewardship

1. Bank management
2. Woodland and grassland buffer strips on cultivated land and grassland land
3. Winter cover crops
4. Water course fencing
5. Enhanced management of maize crops

## Summary

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### CSF

- Very prescriptive
- Focused on agriculture
- No options for sub surface drainage or roads
- Still end of pipe focused

### ELS

- More options available and covers protection of wildlife as well as reduction of sources
- No options for road networks

### Road networks and Sub surface drainage

- Could be significant s-p-r but there is no scheme to deal with them

## Conclusion

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1. Need to be integrated at the catchment level
2. Funding has been put into agriculture. It is a big polluter, but needs to be incorporated into the catchment as a whole
3. Need to find most cost effective measures to reduce sediment in rivers, therefore need to understand what the biggest risks are and how to manage them
4. By implementing buffer strips on land that has sub surface drainage you are losing crops and not stopping all the sediment
5. Schemes like ELS and CSF should be less prescriptive and allow for the variation between catchments
6. Sub surface drainage needs to be included in agri-environmental schemes

**Thank you**