Assessing the impacts of climate, groundwater and land use on regional geomorphology

British Geological Survey
NATURAL ENVIRONMENT RESEARCH COUNCIL

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The CLiDE Environmental Modelling Platform

The CLiDE (CAESAR-Lisflood-DESC) platform integrates a variety of modelling components in order to represent coupled environmental processes and assess their co-evolution over daily to centennial time-scales. A distributed surface-subsurface water partitioning component lies at the platform centre providing key linkages between the atmospheric, sediment transport and debris flow components. These components and their linkages allow the platform to used to study: process understanding; baseline reconstruction; and future states of environmental systems.

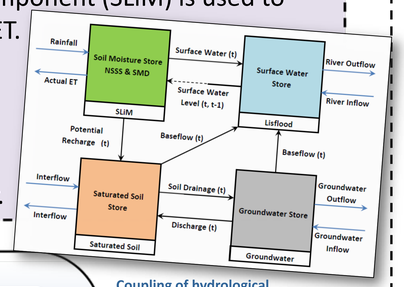
CLiDE can operate on a range of temporal (minutes to millennia) and spatial (cm to km) scales, however, due to the resolution of the driving catchment scale datasets and the simulation time constraints, CLiDE is best suited to mesoscale simulation.

Climate

- Distributed precipitation and evapotranspiration (ET) used to drive the surface hydrology.
- Climate can be perturbed to study the impacts of changing climate on coupled environmental systems.

Hydrology

- A surface water partitioning component (SLiM) is used to determine runoff, recharge and ET.
- Shallow and deep groundwater flow allows baseflow return to rivers.
- The hydrodynamic model Lisflood transports surface water.



Coupling of hydrological processes within CLiDE

CLiDE

Major Components

Fluvial Sediment Transport

- Sediment transport controlled by the CAESAR model and driven by the surface water dynamics.
- Simulation supports multiple grain sizes transported as suspended sediment or bedload.
- Active-layer method allows a vertical distribution of sediments in addition to a horizontal distribution.
- Sediment layers coupled to the debris flow component.

Debris Flow

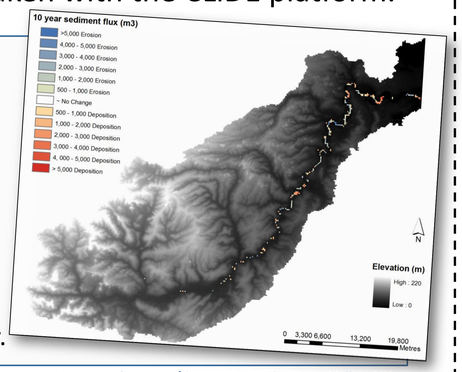
- SCIDDICA debris flow model simulates sub-daily non-fluvial sediment transport.
- Triggered by excessive slope or shallow groundwater levels.
- Momentum allows debris to flow over obstacles.

Platform Application

The coupled nature of the platform has allowed a number of mesoscale geomorphological assessments to be undertaken in a variety of environments. Here we present some of the past and ongoing research undertaken with the CLiDE platform.

Fluvial Sediment Fluxes

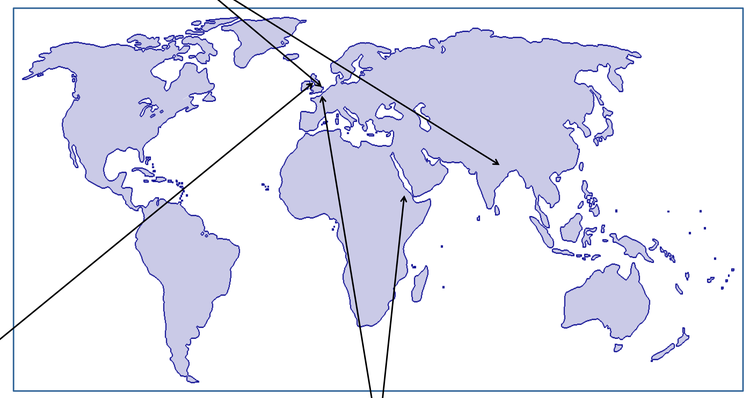
- Study in the **Nene Valley** , **UK**, revealed which sections of the river system were most susceptible to erosion/deposition and how dynamic the river morphology was over the past century. This dataset was used to determine the potential for storing or releasing legacy phosphates in fluvial sediment.
- Currently being used in the **Ganges Basin**, **India**, to assess the impact of changing land use, land cover, groundwater management and climate on catchment erosion and morphology.

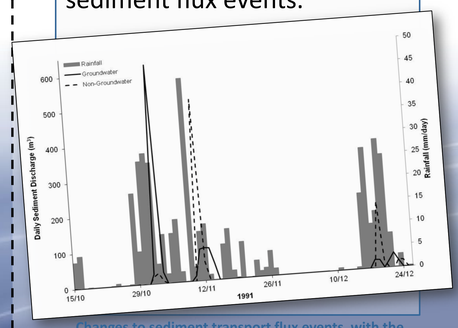


10 years of erosion/deposition in the Nene Valley, UK

Groundwater Influences

- Groundwater is often neglected in landscape evolution modelling, however it has a major influence on river flow in some catchments.
- Simulation of the **Eden Valley, UK**, showed that groundwater can impact the magnitude and the spatial and temporal distribution of sediment flux events.





Changes to sediment transport flux events with the inclusion of baseflow return, Eden Valley, UK

Gully Head Development

- Ongoing research in the **Aa Valley, France**, and the **Geba Catchment, Ethiopia**, are looking at the development of gully heads under differing environmental conditions.
- High resolution field data is being used to determine the ability of landscape evolution models to simulate development.

3D representation of gully head incision in the Aa Valley, France.