The impact of climate change is typically cast in terms of the change in one of a few climate parameters (for example, temperature, precipitation, or water vapor). Another category of impact, and one that is relatively poorly understood, is the direct impact to specific coupled physical-biological environments. Environmental response to climate change is potentially complex, as there are multiple surface-processes coupled to varying degrees, and the system can have more inertia (or memory) than the climate system. There is, for example, potential for non-linear responses to slow, or uniform, changes in the external (climate) forcing. In response to the lack of appropriate holistic models tackling environmental change, we initiated a research programme to address the dynamics of environmental sensitivity to climate change (DESC). The DESC project seeks to explore the interactions that exist between Earth systems at a range of spatio-temporal scales by coupling current landscape evolution modelling technologies to a host of bespoke geo-processing modules. Landscape evolution models are well established, providing the perfect base with which to fuse a variety of Earth systems models, thus allowing new research to be undertaken into the inter-discipline feedbacks that determine the role of future climates in shaping the geosphere. DESC currently uses the well established CAESAR model (Coulthard and Van De Wiel, 2006) as its kernel; a two-dimensional cellular automaton landscape evolution model which has a modular design and great versatility in the range of simulated spatio-temporal scales. Initial research focused on the loose coupling of CAESAR to the groundwater flow model ZOOMQ3D, investigating the role of groundwater on sediment transport at the catchment scale. The Eden Valley (Cumbria, UK) was selected as a test bed for the coupled model and results suggest that although the volume of sediment transport through the catchment is not altered, the distribution of sediment erosion and deposition in the simulation is perturbed by the interplay of baseflow conditions and storm intensity and frequency. Using the two complex, computationally intense coupled models over the catchment scale on the required temporal scales crated an undesirably long processing time (in the region of one week of processing per five years of simulation). The groundwater aspect of the coupled model is currently being replaced by a bespoke, cellular, distributed, coupled surface-subsurface water flow model, which will be incorporated into CAESAR. This hydrological model has decreased data storage needs and a simulation time in the region of two orders of magnitude faster than the original model, whilst continuing to calculate a range of hydrological parameters at individual nodes. Future versions of DESC will incorporate shallow landslides, dynamic vegetation, hillslope creep and transient discharges, creating a base model from which a variety of climate-derived, looped feedback research can be undertaken at daily to centennial timescales.