How Viridian Modelling works

The Viridian modelling system (Viridian) is a novel GIS planning tool, developed to mitigate dangers to the water supply in river landscapes using nature-based solutions. The scientific research underpinning Viridian has been collated from hundreds of papers by the Natural Capital Project and University of Leeds. The engine at the core of Viridian is the 'Resource Investment Optimisation System' or RIOS. RIOS was created by the Natural Capital Project[1] to account for biophysical, social and economic data when designing cost-effective investments in watershed services in Latin America [4]. Viridian transposes and extends the functionality of RIOS to UK river catchment/subcatchment regions, and is weighted towards using biophysical data to improve ecosystem services provided by those regions.

Landscape issues are interpreted as a combination of up to five Viridian objectives. Viridian works by grid-based map analyses of the risk factors associated with each objective. These objectives are: 1. erosion control, 2. reduction of soil adsorbing pollutants (e.g. phosphates), 3. reduction of water soluble pollutants (e.g. nitrates), 4. flood mitigation, and 5. groundwater retention/baseflow control.

The risk factors are indexed and all locations within the catchment of interest are ranked by appropriately combining each indexed (and appropriately weighted) factor. Simultaneously, Viridian models hydrological transport through the landscape. The final calculation determines where habitat development would be best placed to intercept these flows, down to where placement is least favourable, and a fiducial threshold is applied to select the highest ranked areas to achieve the objective(s). This produces a map of where the most effective interventions should be implemented.

Strengths

By adopting a ranking methodology, Viridian is robust to systematic biases that may exist in any given data source. In this way, individual parameters and measurements minimally impact upon the output map of recommendations. In parallel, if a catchment manager is more risk averse, then the output map increases the area of habitat development by moving the ranking threshold further down the ranks. There are a multitude of ecosystem service developments employed by Defra's catchment treatments, with varying degrees of evidence supporting them. To reduce the risk of poor decision making, Viridian only invokes interventions that have proven benefits [2]. Viridian stands to improve greatly as the body of scientific knowledge increases.

Assumptions

Whilst data can be quickly evaluated for suitability within Viridian, the data is assumed to be broadly correct. As such, fundamental flaws that may exist in alternative data sources will skew Viridian' recommendations. To avoid such biases, data is evaluated in-house.

Weaknesses

Viridian does not, per se, identify problems. That is, if a landscape is healthy then the Viridian platform will still produce recommendations based on the determined rankings. Similarly, whilst the ranked recommendations are self-consistent (i.e., the best intervention for the landscape is truly the best interpretation of data), the impact of interventions is not well measured by Viridian. Indeed, to date, decisions arising from ecosystem service assessments worldwide are rare [1]. Given the diversity of river catchments, accurate calibration of landscape interventions on sparse information demands more knowledge than is available, especially given climate change [3].

Future

Viridian can learn from the results of test catchments that have implemented similar measures in the UK and around the world. This is caveated by the fact that previous ecosystem service development may have been undertaken with other considerations in mind (using non-proven

methods, limited to the land/methods that the land-owners approve, etc). In parallel, we are discussing specific catchments with academics, hydrologists, and other water professionals, and comparing their recommendations with those of Viridian.

The advance of research and development of various hydraulic/catchment models is allowing the continuous development of Viridian. One aspects of this is calibrating and integrating Viridian with other, open-source modelling techniques to quantify the effects delivered by the various interventions that Viridian suggests. In this way, Viridian will be able to identify the best solutions, then quantify the impact they will have on local problems such as flooding or river pollution.

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[1]A partnership between Stanford University, the University of Minnesota, The Nature Conservancy, and the WWF 1References

[1] Johannes F¨orster, Jan Barkmann, Roman Fricke, Stefan Hotes, Michael Kleyer, Susanne Kobbe, K¨ubler Daniel, Christian Rumbaur, Marianna Siegmund-Schultze, Ralf Seppelt, Josef Settele, H. Joachim Spangenberg, Vera Tekken, Tom´aˇs V´aclav´ık, and Heidi Wittmer. Assessing ecosystem services for informing land-use decisions: a problem-oriented approach. Ecology and Society, 20, 2015.

[2] Paul Kay, C. Anthony Edwards, and Miles Foulger. A review of the efficacy of contemporary agricultural stewardship measures for ameliorating water pollution problems of key concern to the uk water industry. Agricultural Systems, 99:67–75, Feb 2009.

[3] Stephen Polasky, R. Stephen Carpenter, Carl Folke, and Bonnie Keeler. Decision-making under great uncertainty: environmental management in an era of global change. Trends in Ecology & Evolution, 26:398–404, Aug 2011.

[4] Natural Capital Project. Water Funds in Latin America. Brochure, 2015.