SAGIS Source Apportionment Geographical Information System: Its use in investment planning to assess Water Framework Directive compliance.

The negative effects of specific chemical pollutants in waterways has been well documented, these range from endocrine disruption caused by pharmaceuticals to eutrophication caused by nutrient loading. Sources of problem chemicals are wide ranging and include industrial discharges, the water and sewerage industry, agricultural and urban runoff.

Directive 2000/60/EC establish a framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater. National regulators are responsible for achieving compliance with the Directive by engaging with all stakeholders to manage river water quality and influence change in industry.

In 2009 the environmental regulator for England and Wales, the Environment Agency, published a paper entitled 'The Source Apportionment of Chemicals'. This paper discussed the origins of specific chemical pollutants in waterways and identified the importance of mapping cumulative loads and their sources. This led to the concept of a 'Source Apportionment' model which was then developed between the Environment Agency and United Kingdom Water Industry Research (UKWIR).

The Source Apportionment Geographical Information System (SAGIS) represents the evolution of mass balance water quality modelling. It enables water quality planning centred around engaging all contributing sectors and implementing the 'Polluter Pays Principle'.

This SAGIS model is now freely available to all UK water companies and Environment Agency regions of the UK.

System

The system utilises Simulated Catchment (SIMCAT) software to run mass balance equations which reference data stored in national and regional databases, these are then placed in the form of map outputs in the GIS interface. Outputs are visual and easily interpreted, this enables users to understand and interpret model results.

The model accounts for point and diffuse sources including industrial discharges, waste water discharges, combined sewer outfalls, storm tank discharges, mine waters, arable runoff, livestock inputs, atmospheric, urban runoff and on site waste water treatment works. The model accounts for a range of chemical determinands including both dissolved and particulate metals, poly-aromatic hydrocarbons, di(2-ethylhexyl) phthalate, phosphate, ammonia and nitrate.

Dŵr Cymru

Dŵr Cymru Welsh Water (DCWW) is the statutory water and sewerage undertaker for much of Wales. We have been working with SAGIS to assess compliance of waterbodies within Wales with the Water Framework Directive. The waterbodies into which assets discharge have been modelled to show cumulative load and concentration.

As contributors to the issues effecting riverine water quality Dŵr Cymru must ensure that all their assets are performing within their consents and that actions are being implemented to ensure the

future ‘good’ status of rivers within Wales. This includes planning investment at treatment works which contribute to rivers not in favourable condition.

SAGIS allows Dŵr Cymru to assess the quantitative contribution of pollutant loads made to each waterbody by the activities of the company, and by other sectors; thus informing the selection of cost effective and proportionate measures to achieve good status.

The system allows the overlay of additional layers. These can be used to highlight where a failing river is also a ‘Site of Special Scientific Interest’ (SSSI), or if there is a dense population of septic tanks which could be providing additional diffuse nutrients to the river system.

Image 1. SAGIS interface with output layers

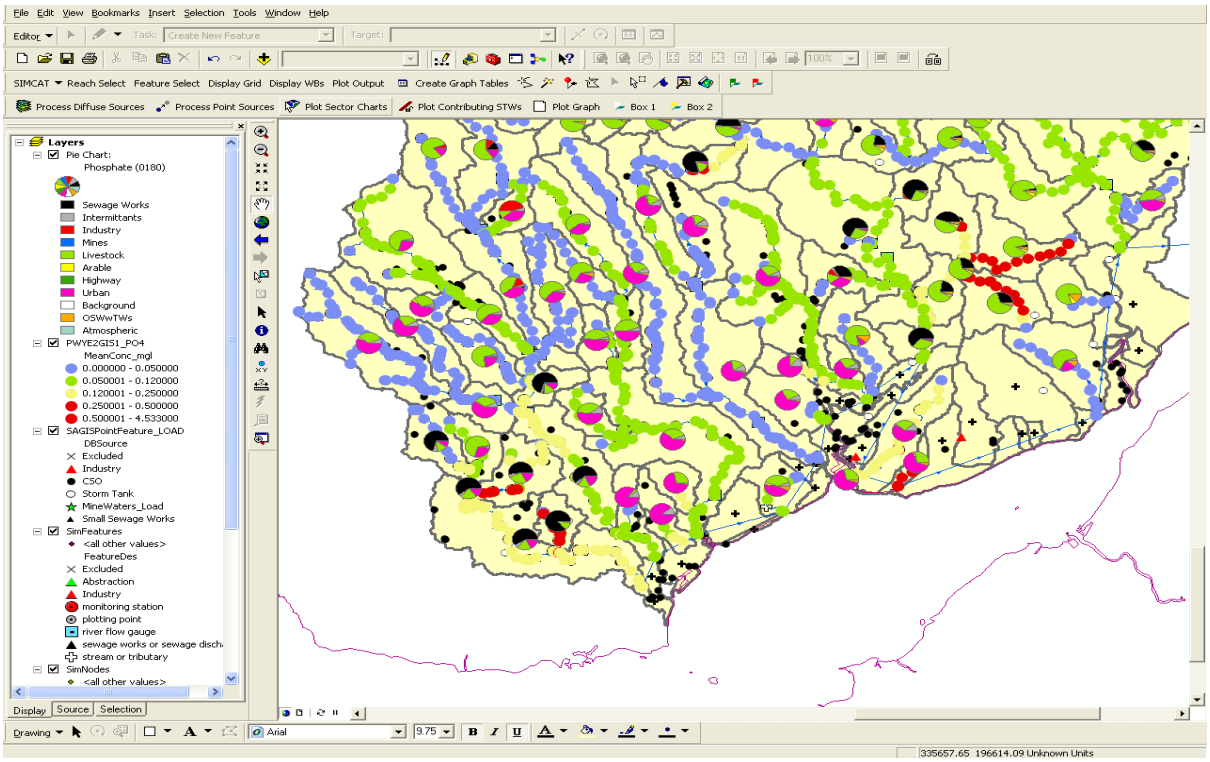
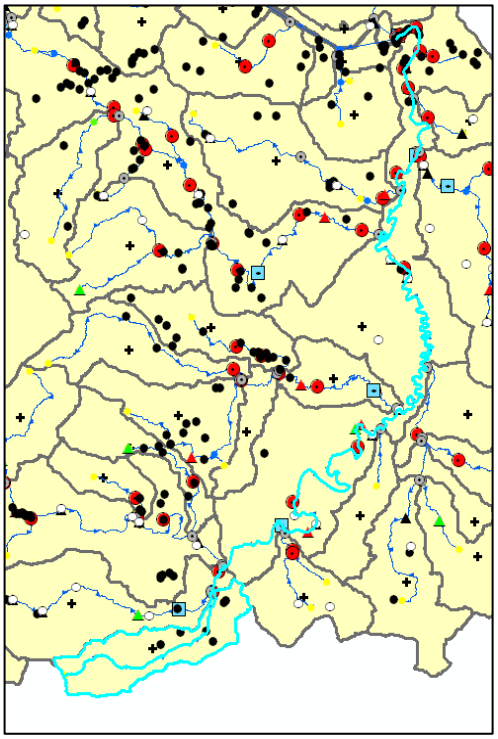


Image 2 shows the model interface with chemical source apportionment layers, the pie charts show the percentage contribution of each sector for each waterbody boundary. The colour symbology shows the compliance of that point on the river according to the Water Framework Directive standards adopted in the UK. The blue points show ‘excellent’ status, green shows ‘good’ status, moderate is ‘yellow’ and the red points show areas that are ‘poor’ status. Also mapped are sewage treatment works, industrial discharges, abstraction points and a number of intermittent discharges.

Case Study

This case study shows how the tool can be used to aid business case investment planning. As Dŵr Cymru is currently still in the process of planning for a regulatory price review in 2014, the names and values have been changed. An example river was chosen to represent the advantages of small scale scenario modelling.

Image 2 -the case study river shown in the SAGIS interface



Graph 1 shows the concentration of phosphate in mg/l against distance from the headwater. Also plotted are WFD classification boundaries. At 0.05mg/l and below shows excellent status, 0.12mg/l shows good status.

The phosphate concentration is dependent on the flow volume within the river. The high levels of phosphate seen between 0 and 10 km is due to the low flow within the river, the concentration decreases at the confluence point as the river flow increases.

Graph 1 also contains sample data which shows a close correlation to the simulated results. Increases in concentration are seen at the point of waste water treatment works discharges.

Graph 2 is a chainage plot with sector apportionment.

SAGIS has the advantage of running multiple scenarios in a short space of time, where the graph shows that waterbodies are not meeting good status; discharge concentrations can be edited to reflect investment at works.

Graph 3 represents the addition of phosphate treatment at two treatment works. Changes have been made to represent phosphate removal to 1mg/l in Wallis and Cwmderi treatment works.

Editing the data in the model and rerunning the calculations shows an improvement in water quality. The river now meets good status and the proportion of water industry input is greatly reduced.

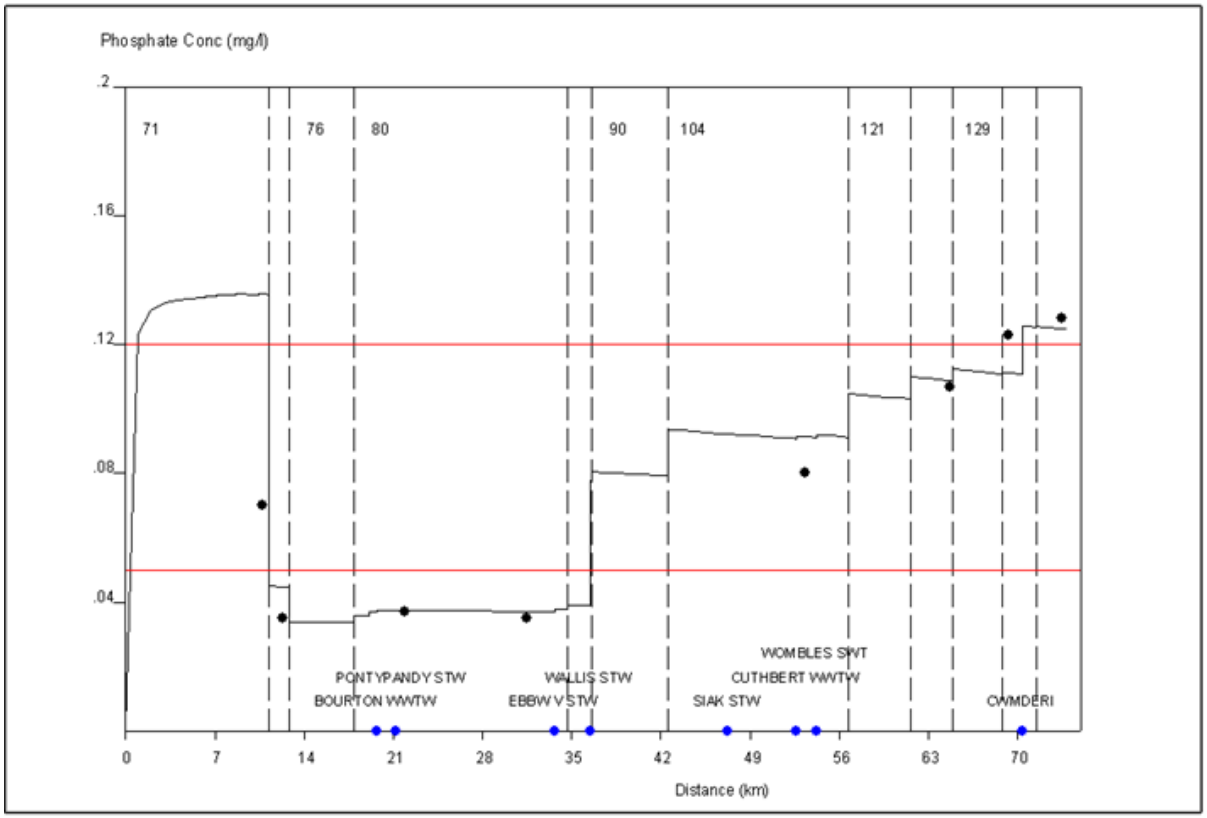
Limitations

SAGIS models are not time based and do not show seasonal variation; river flow can vary according to seasonal changes which would have an impact on results. The model will also always be a simplified version of reality and so must be used as an advisory tool and not as the sole basis of decisions. Data is often subject to change and so the models require regular updates. Livestock and arable inputs have been calculated from the ADAS models PSYCHIC and NEAPN and have been shown to overestimate inputs in some areas. There is also a related issue, of changing crop types and land use.

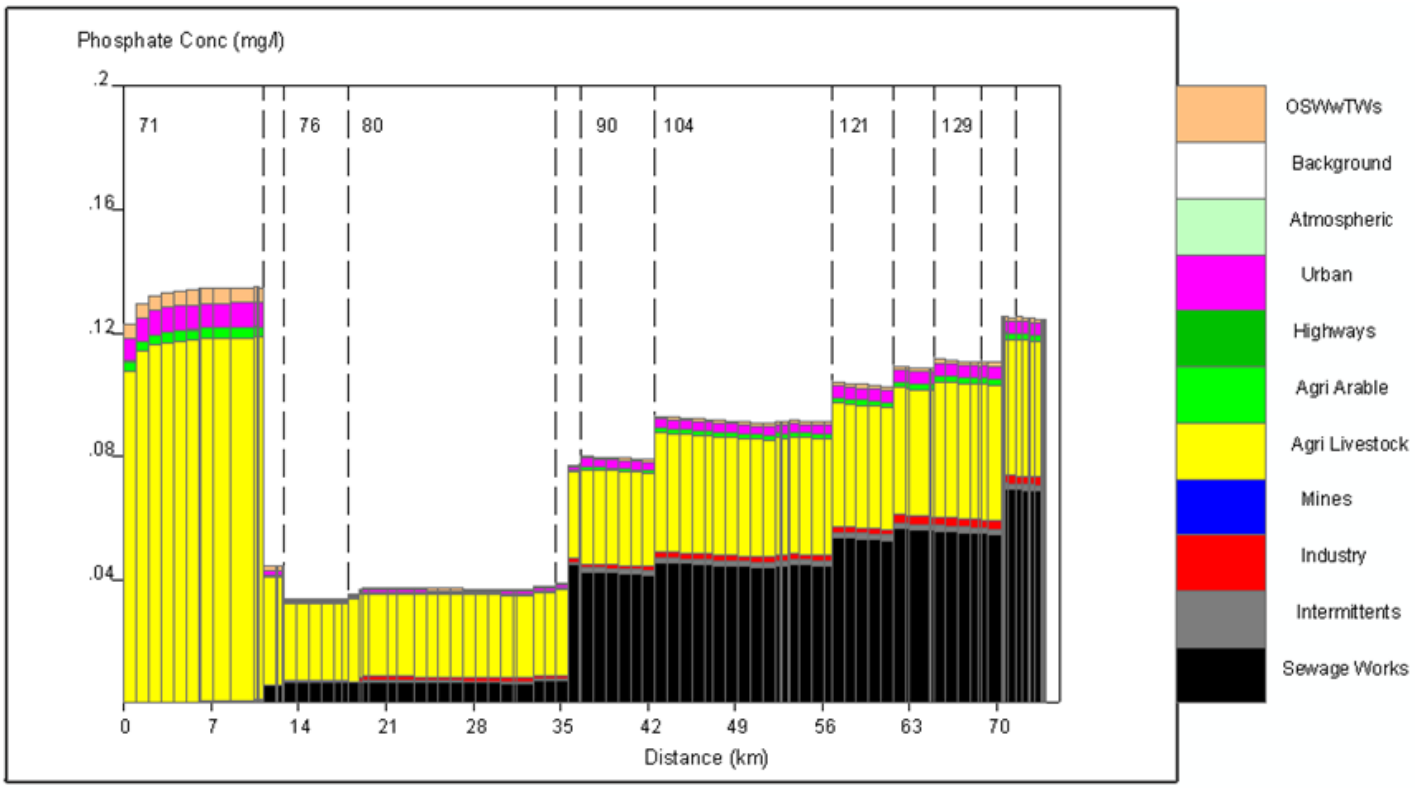
All the data within the models must be regularly updated to maintain an appropriate reflection of reality.

Case Study Graphs

Graph 1 Phosphate in mg/l along the distance of the river.

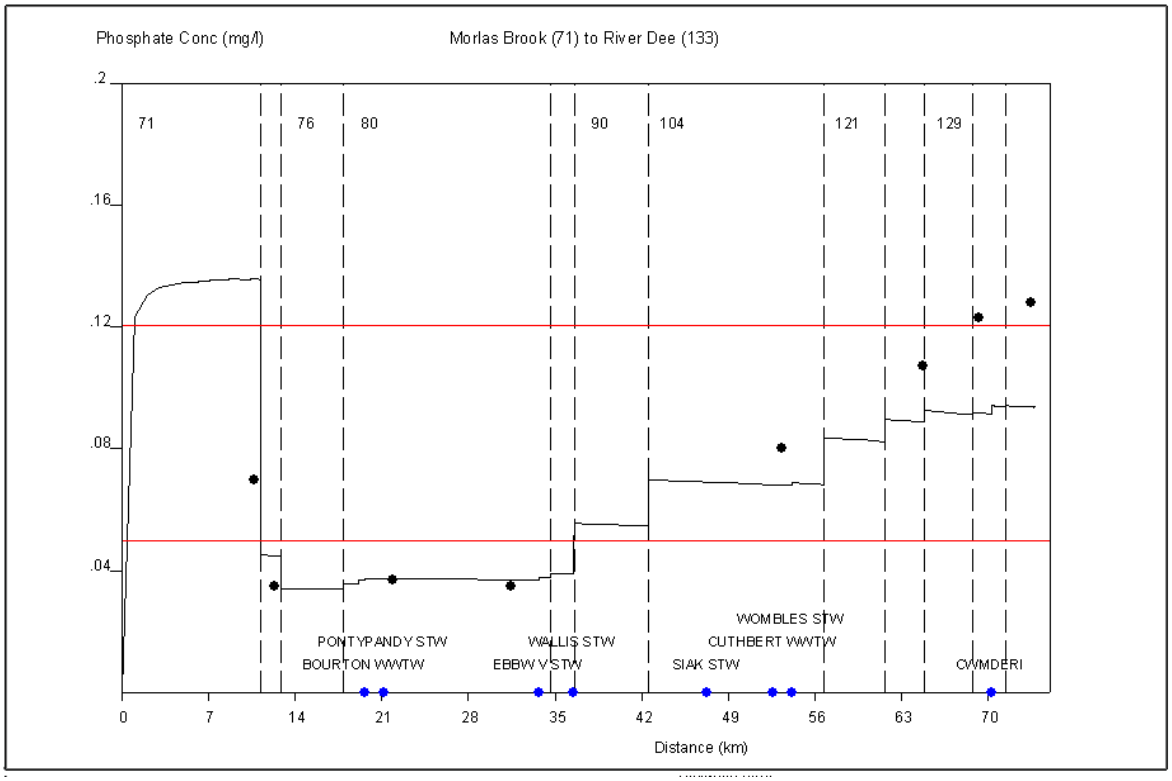


Graph 2 Phosphate in mg/l along the distance of the river including sector apportionment



Graph 3 Phosphate in mg/l along the distance of the river

Wallis STW set to 1mg/l final effluent concentration Cwmderi STW set to 1mg/l final effluent concentration



Graph 4 Phosphate in mg/l along the distance of the river with sector apportionment