Determine Whether a Project Degrades the Environment (Newsletter)*

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Answers to these two questions support decisions based on environmental data:

1. Why do we observe the values we have?
2. How can we identify natural variability and anthropogenic effects?

The first question can be answered using an appropriate regression model that relates mean or quantile values of the continuous response variable to the range of values of one or more explanatory variables. Explanatory variables frequently are categorical; that is, names such as soil type, compass direction, and dominant vegetation rather than continuous variables such as temperature and slope. Mixed models analyze continuous and categorical variables in the same model and yield insights into why we obtain the values we have. Using several regression models allows us to select the one best fitting the available data by using the Akaike information criterion (AIC) to measure their relative quality in explaining the data.

Applying mixed effects regression models instead of comparing individual measurements to a threshold value benefits all decision-makers. Perhaps the most important is that a quantitative determination can be made whether the project might (or does) have adverse environmental impacts.

Surface water chemical concentrations might be very high in one reporting period compared with previous periods. The difference might result from low flows in late summer or snowmelt runoff transporting large amounts of eroded sediments in the spring. The cause can be known with confidence only if explanatory variables have been measured at the same time and location as the response variable.

Populations of various animal species might change during construction and operation of a mine, power plant, or pipeline/electrical transmission corridor. The reason might be habitat loss, increase in predator numbers, or the use of project infrastructures as refugia or protected breeding sites. Only by collecting data on potential explanatory variables can the observed population numbers be explained.

Ground water pollution is a major concern everywhere. Kriging models permit quantification of concentration changes by distance and direction; those changes can be explained by different soil types, predominant vegetation, topography, geochemistry, or other environmental factors.

To answer the second question use one or more of several types of statistical models. All these can distinguish anthropogenic project effects from inherent natural variability.

The environmental data are initially visually analyzed by plotting them by time, location, or both. Boxplots are highly effective in communicating the meaning of these data to non-technical decision-makers. Statistically significant differences are clearly visible and anthropogenic changes stand out from natural variability.

Time series models accommodating variable data periods are built to fit complex environmental data. Removing seasonal trends reveals whether there is meaningful underlying change. Apply generalized additive mixed models (GAMM) to these time series to explain the underlying changes and to forecast observations of the response variable in the near future.

Cluster analysis groups data by their degree of similarity. If all samples collected prior to construction and operation of a project cluster far from samples collected during operations the degree of difference may reflect either the project itself or natural factors (drought, excessively wetness). Only when potential explanatory variables have been measured along with the response variables can the reason be ascribed with confidence.

It is in everyone's best interests to understand why measured and observed environmental data have the observed values and to quantitatively separate project-caused changes from inherent natural variability. Operators, regulators, consultants, and attorneys can make technically sound and legally defensible decisions only when understanding local ecosystem dynamics and how projects fit into that landscape. This process has value for environmental assessments, permit compliance monitoring, remediation, reclamation, and all other activities requiring collection, analysis, and reporting of environmental data.

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