How Much is Your GIS Worth?

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Table of Contents

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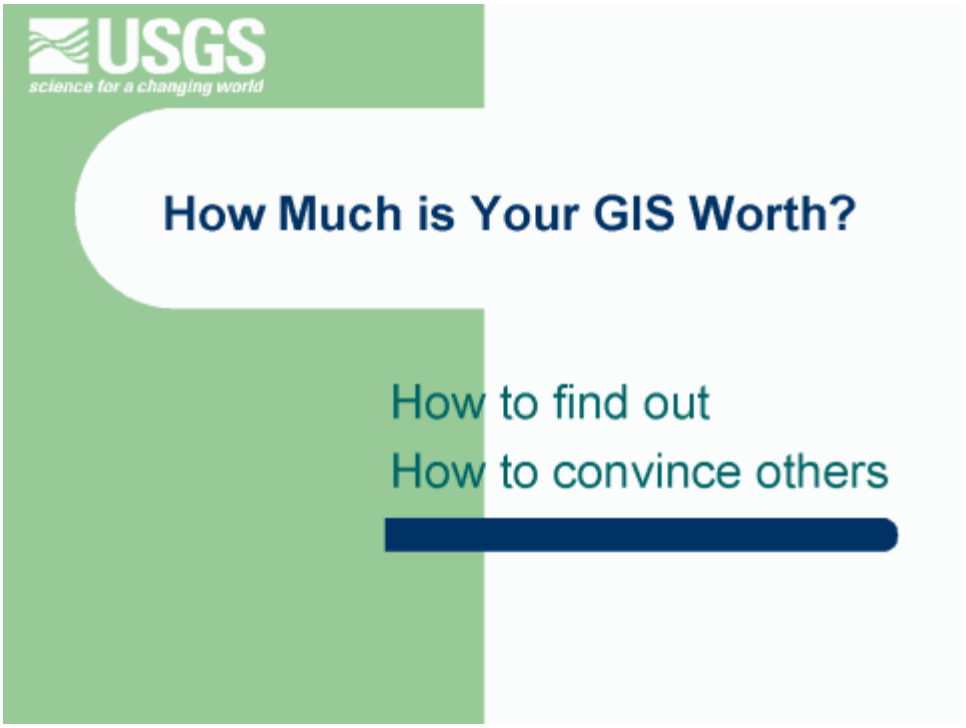
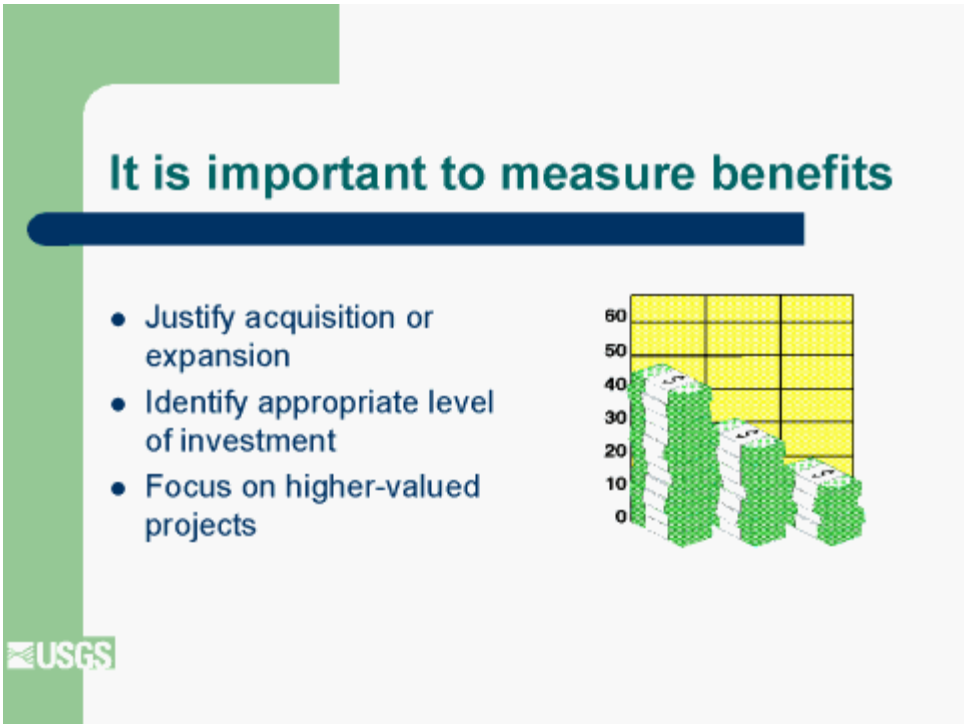


Slide 1 of 11

Notes:

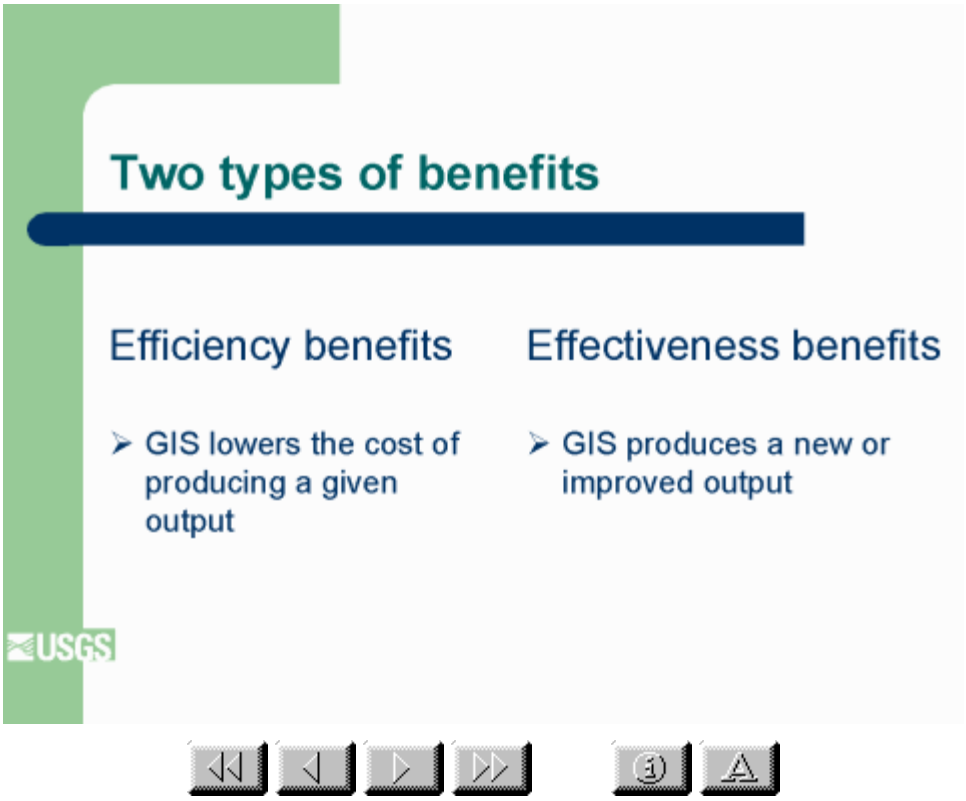
At the U.S. Geological Survey we are naturally interested in measuring the value of digital geographic data, since we produce so much of it. I'm here to share with you some results of our research into the value of GIS, and to offer some advice on how to make practical use of our results.



Slide 2 of 11

Notes:

We all recognize that it is important to measure the benefits of a GIS installation. On the most practical level, you are unlikely to get approval for the sizable investment GIS requires unless you have solid documentation of significant benefits. Even if we set aside this pesky management concern, there are still good reasons for measuring benefits. We don't simply decide to invest in GIS or not, but must also decide how large an investment. It makes little sense to invest in a top-of-the-line GIS with all the bells and whistles if a simpler desktop GIS will generate the same benefits. Once a GIS capability has been established, there are many possible projects competing for scarce GIS resources. Without a reliable way to estimate benefits, lower-valued projects may be allowed to consume resources that could better be used on more valuable projects.



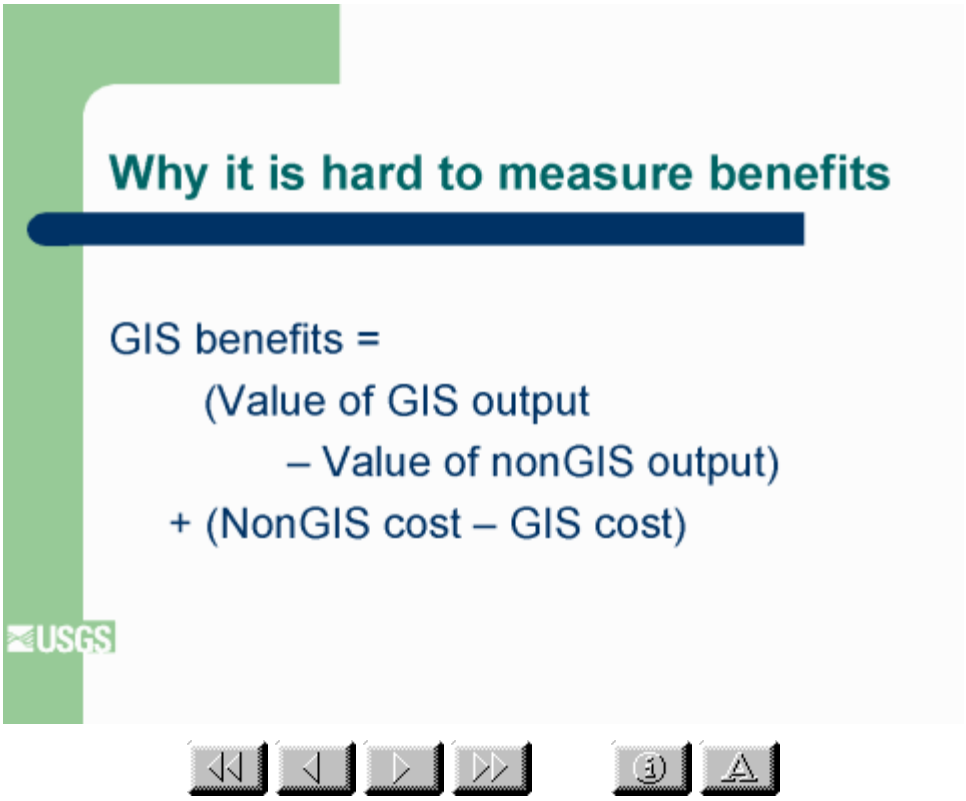
Slide 3 of 11

Notes:

The first step is to recognize that there are 2 qualitatively different types of benefits that come from the use of a GIS.

Efficiency benefits results when a GIS is used to do a task previously done without a GIS; the same quality of output is produced, but at lower cost. For example, cut and fill calculations can be made by applying planimetric techniques to contour lines on a graphic map or by manipulating digital elevation data in a GIS. Both methods yield the same results, but a GIS is much faster and easier.

Effectiveness benefits result when a GIS is used to improve the quality of a current output or to produce an output not previously available; that is, the GIS is used to do something that could not or would not be done without it. For example, a GIS can quickly and easily produce maps showing how the proposed route for a new road would affect a series of environmentally sensitive resources. Such maps could be manually drafted, but the process would be so expensive that they probably would not be prepared. A GIS can also overlay a large number of separate environmental themes and calculate an overall impact. When there are more than just a few overlays, this task is simply not feasible using non-GIS techniques.

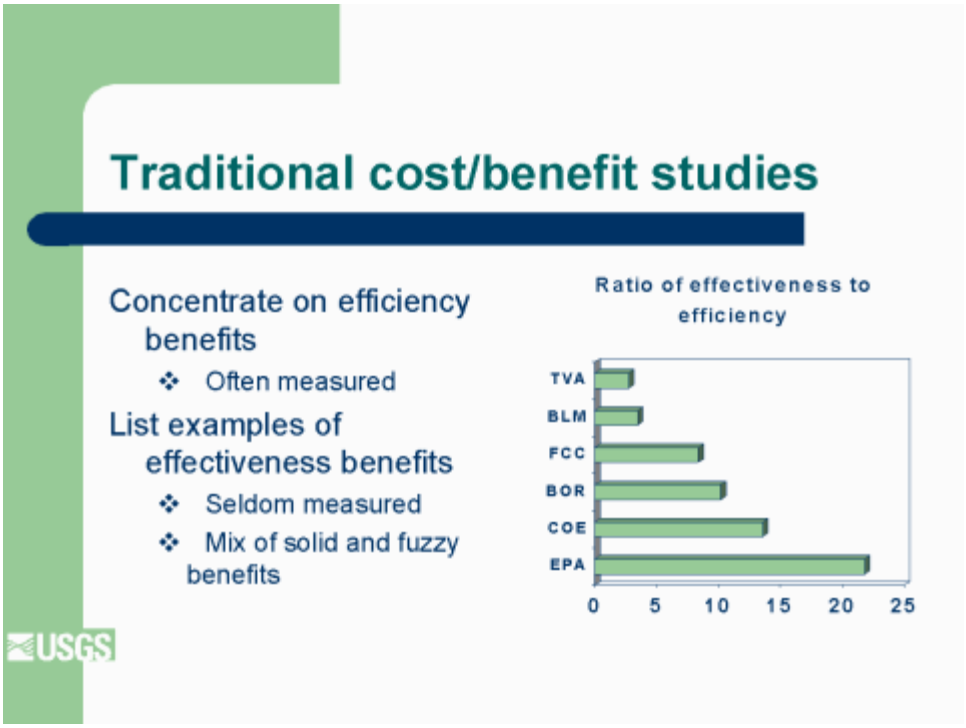


Slide 4 of 11

Notes:

Here is the general formula for GIS benefits. The sum of the increase in the value of the output plus the decrease in the cost of producing the output. Notice that when the output does not change, the first term vanishes, leaving pure efficiency benefits. When the cost does not change, the second term vanishes, leaving pure effectiveness benefits.

It is hard to measure GIS benefits primarily because it is hard to measure the value of outputs (either GIS or nonGIS).



Slide 5 of 11

Notes:

The difficulty in measuring the value of outputs explains why cost/benefit studies of GIS traditionally take the approach they do. Most published GIS cost/benefit studies concentrate on efficiency benefits. This is because it is relatively easy to estimate costs and to measure cost reductions.

The more difficult to measure effectiveness benefits are usually not measured. Instead the study often provides a laundry list of claimed output improvements. Commonly the list of effectiveness benefits includes both rock solid ones (for example, more accurate property assessment, leading to higher property tax revenue) and warm fuzzy ones (for example, public access to assessment maps enhances the public's trust in the fairness of the process.)

This concentration on efficiency benefits has 2 major consequences. First, it undervalues GIS technology, which can cause the delay or even cancellation of GIS investments. Second, it suggests that expenditures on GIS technology are justified only when they will result in large efficiency benefits. This is a serious mistake. The chart shows the ratio of effectiveness to efficiency benefits for 6 Federal agencies. In each case effectiveness benefits greatly exceed efficiency benefits, often by a factor of 10 to 1 or higher. For many organizations, the real value of a GIS is not that it helps them do their work cheaper, but that it helps them do their work better.

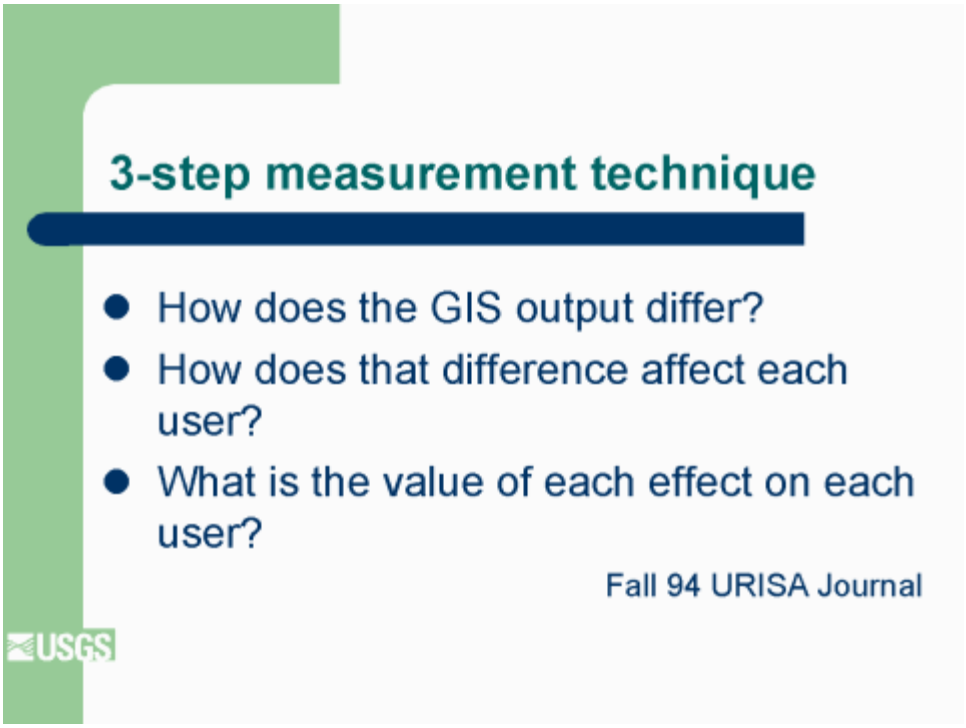
Slide 6 of 11

Notes:

In order to improve GIS cost/benefit studies, we need to do two things.

First, we need to do a better job of measuring effectiveness benefits. This can be done: I'll give you some ideas how in a moment.

Second, we need to stop claiming the warm fuzzy benefits. A laundry list of benefits weakens a study rather than strengthening it. There are generally plenty of solid measurable GIS benefits to point to. Claiming warm fuzzy benefits tends to ignite skepticism toward even the solid ones. Resist the temptation to pad your study with fuzzy benefits.



Slide 7 of 11

Notes:

Most GIS effectiveness benefits can be measured by the following 3-step technique.

- Identify all the ways in which the GIS output differs from the previous nonGIS output. Maybe the GIS output is more accurate, or ready sooner, or includes a map not previously available.
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2. For each difference, identify how that difference affects each user. What does the user do differently because of the GIS output? Perhaps the user makes a better decision, finds more errors, or checks factors not considered before.

3. Measure the value of each effect on each user. By narrowing the focus to the point where pertinent questions can be asked about the value, it is usually possible to measure benefits that previously had appeared to be nonquantifiable.

The technique is discussed in more detail in a URISA Journal article in the Fall 1994 issue.

Slide 8 of 11

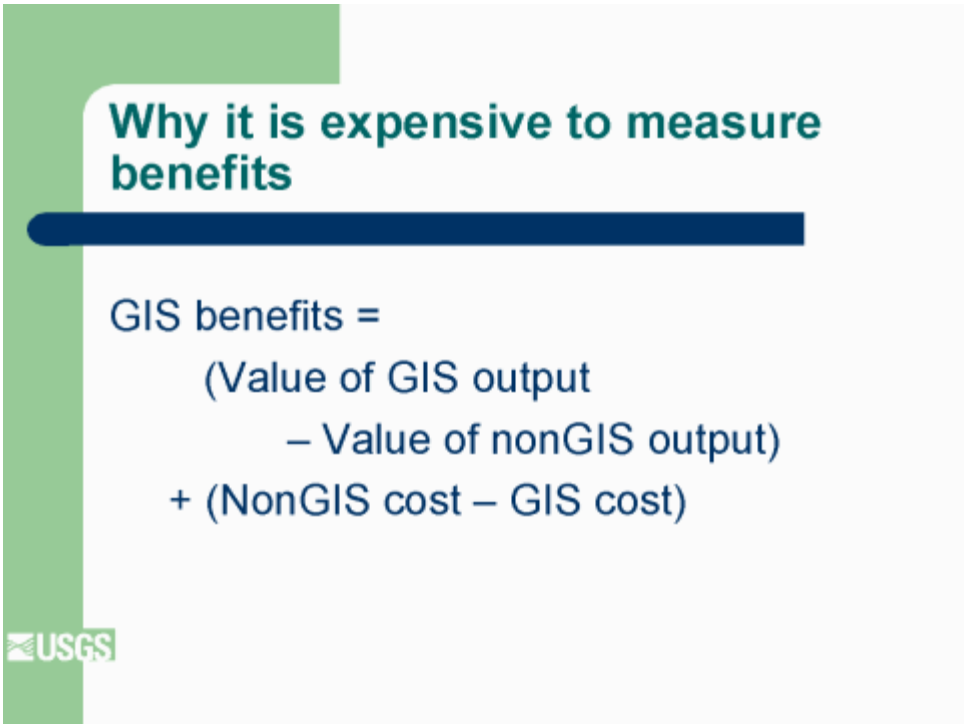
Notes:

Here is an example from the Wisconsin Department of Transportation. They use GIS in a pavement management program.

The difference in outputs is that the GIS produces graphic product displays that were not previously available.

The first major effect of the graphic displays is to improve quality control. Errors that would stay hidden in long columns of numbers jump out at you from a picture. The improved quality control lets pavement managers identify highway segments badly in need of renovation that had been overlooked in the previous manual process. Higher valued segments replace lower valued segments. Based on the average value of a mile of highway renovation, the GIS benefit is measured at $500K per year.

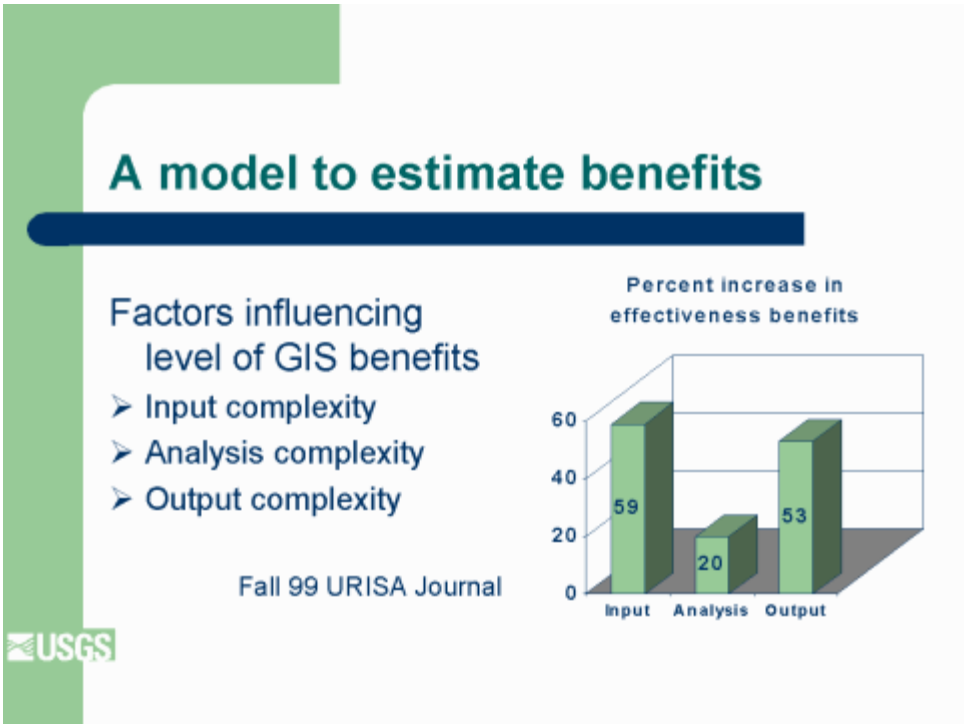
The second major effect of the graphic displays is to provide better information about pavement sections needing detailed analysis. Detailed information that once took 40 hours of research to obtain, now is available at the touch of a button. As a result, pavement managers now look at the detailed information whenever a segment is likely to benefit from additional study, rather than just when it most obviously would benefit. Based on the number of times this is done (with the previous expense setting an upper limit), the GIS benefit is measured at $18K per year.



Slide 9 of 11

Notes:

The general formula shows why benefit measurement of a proposed GIS application is expensive. Of the four terms in the formula, NonGIS cost is the only one for which an organization is likely to have reasonably accurate information. Estimation of GIS cost could require an extensive pilot test. Estimation of the value of outputs requires identification of users and uses of the outputs, impacts of changes in outputs on the users and uses, and dollar valuations of the impacts, none of which is likely to be easy. Because this is such a daunting task, it is not surprising that quantitative measurement of GIS benefits is so rare.



Slide 10 of 11

Notes:

One way to avoid the expensive process of directly measuring the benefits of using GIS is to identify and stress factors that contribute to a successful GIS application.

USGS research focuses on the complexity of a GIS application as the key factor influencing the level of benefits realized from the application. Complexity was chosen as the key factor because (1) the theoretical direction of its influence on efficiency and effectiveness benefits is clear, (2) it is identified as being an important GIS success factor in several published studies, and (3) it proved to be a useful and measurable concept in a series of USGS case studies of specific Federal GIS applications.

There are various aspects to the complexity of an application.

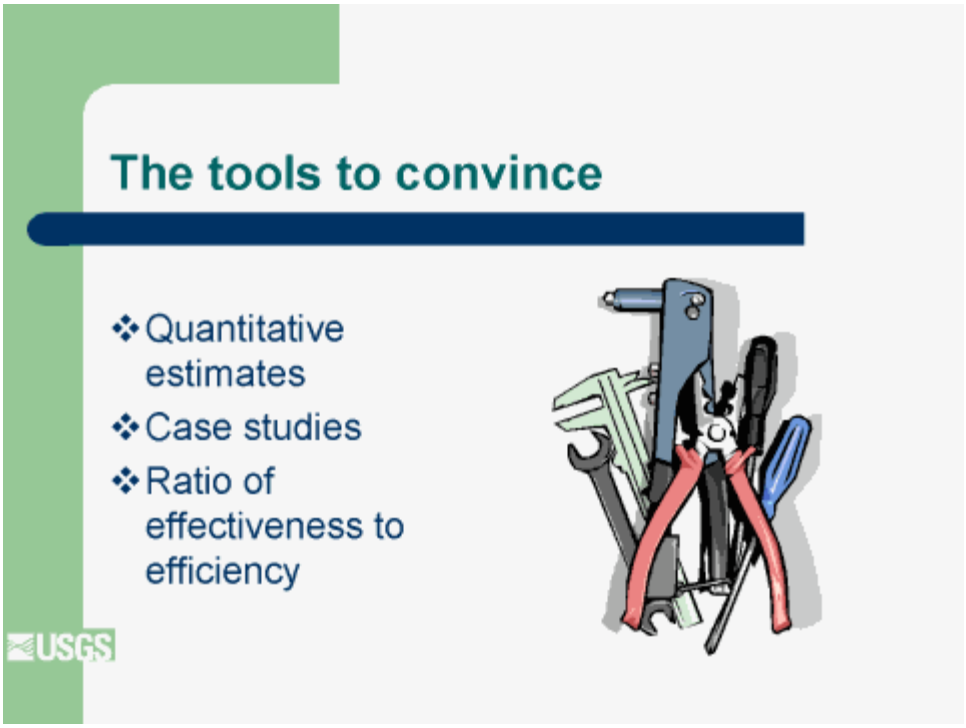
1. Input complexity concerns the data themes needed to perform the application. It involves such things as the number and diversity of data themes, the total volume of input data, and the areal extent of the application.

2. Analysis complexity concerns how the data themes are manipulated inside the application. It involves such things as the maximum number of concurrent overlays, the number of steps in the analysis, the number of intermediate data themes created, and the number of potential interactions between data themes.

3. Output complexity concerns the products of the application. It involves such things as the number of distinct uses for the outputs and the likelihood that the outputs will be used in adversarial hearings. The model is discussed in much more detail in a URISA Journal article in the Fall 1999 issue.

Each complexity factor can be expected to influence the level of efficiency and effectiveness benefits in a predictable way. The chart shows the impact on the level of effectiveness benefits of a doubling in each type of complexity.

The model can be used to estimate gross levels of effectiveness and efficiency benefits for a series of GIS applications. You can then conduct a small number of direct benefit measurements to verify the reasonableness of the gross estimates. This is much better than a traditional GIS cost/benefit study, but much cheaper than direct measurement of all effectiveness benefits.



Slide 11 of 11

Notes:

Using the model produces a suite of outputs that together tell a compelling story about the potential value of GIS technology.

1. Quantitative estimates of GIS benefits. Impressive on their own, they can be combined with cost data to produce cost/benefit ratios, net present values, internal rates of return, and project breakeven dates.

2. Case studies of selected applications. These demonstrate in concrete terms that the estimated benefits are real.

3. Ratio of the dollar values of effectiveness to efficiency benefits. This dramatically demonstrates where the value of a GIS truly lies. Typically the ratio will be large, making it clear that GIS is an enabling technology, primarily important because it helps agencies work better, not because it helps them work cheaper.

The Montana Geographic Information Council (MGIC) applied the model to analyze GIS implementations in state and county governments of Montana. They report that “the model is an excellent tool for assessing the benefits of GIS installations.” The full report of the MGIC is available online at: http://www.mt.gov/isd/groups/eacba/eacba_cba.htm.