REVEALING HIDDEN ECONOMIC EXTERNALITIES IN MAJOR PROJECTS WITH VALUE METHODOLOGY

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Author's Biography

Munsell McPhillips has participated as a team member in Value Analysis since the mid-1990's. She has practiced as a science advisor to a governor, a research scientist, and designer in river and ecosystem restorations throughout the US. Her designs evolved from biomedical engineering for human health to sustainability design for the planet. Her value analysis projects have varied from manufacturing, restoration design of natural systems to transportation.

Abstract

An economic externality is a cost or benefit that is not reflected in the price of a project or product. It is borne by those who are not willing parties to the transactions of producing the project. Economists tell us that economic externalities are distortions of our marketplace because some costs or benefits falling outside the project are not accurately reflected in its costs. As VM practitioners, we pride ourselves on our clear-eyed understanding of costs. However, if we cannot articulate the effects of our projects or products on the larger community, we cannot accurately analyze or cost them. By properly examining and eliminating external costs, our adverse impacts on the larger world are reduced and our projects become more sustainable. VM may provide a mechanism for revealing and ameliorating these hidden costs. This paper will address how externalities arise in engineering design, a method for integrating externalities in VM, some approaches to applying economic measures to services provided by nature and how the process influences team member selection.

Introduction

Economic externalities are costs and benefits that often hover around the margins of our projects and can be difficult to pin down. To have an efficient market place, all of the costs of producing a project must be assigned to it. Only then do we have an accurate cost and can we make informed decisions regarding whether or not to pay for the project. Fully burdening a project with all of its associated costs is referred to as internalizing the externalities.

It is important to note that externalities can work in both directions. One example of a positive externality is vaccination against communicable disease. If 99% of a population goes to the trouble and expense of getting vaccinated and not transmitting the disease, the remaining 1% also stays healthy. The people who were not vaccinated are free riders; they derive the benefit but don't contribute to the cost. To the extent that we can identify and quantify positive externalities, the benefits, perhaps expressed as avoided costs, should be accrued to the project. When positive externalities go uncaptured, the project is undervalued and the incentives to proceed are improperly reduced.

Negative externalities are unfortunately easier to envision: increased health care costs and lost work days associated with air pollution or increased water treatment costs caused by water pollution from upstream industry are examples of costs born by people who were not willing participants in the business transactions that caused them. Externalities also arise when we fail to fully account for the economic value of natural capital, the goods and services provided by nature. This failure poses serious business and social risks. Natural capital is the ecosystem service provided by the living world. These services are broadly grouped into four categories: 1) Provisioning services such as food production, raw materials, fresh water and medicinal feedstock; 2) Regulating services including carbon storage, local climate regulation, water treatment and degradation of toxins and pollutants, biological control of pests and vector-borne diseases and pollination; 3) Supporting services including habitat provision and maintenance of diverse, viable gene pools and 4) Cultural services such as recreational spaces, tourism, cultural foundations and spiritual experience (TEEB, 2010). Each of these goods and services has a clear and quantifiable economic value the loss of which is generally a negative economic externality. For example, in 2006 the value of genetic resources in the form of pharmaceutical feedstock alone amounted to US$ 640 billion (TEEB, 2009). Techniques and case studies that quantify the financial value of these services are well documented and increasingly available (Daily and Ellison, 2002).

Most engineering designers earnestly try to incorporate broader interests into their projects and in many respects are successful. In addition to the direct cost of building projects that meet customer requirements, most of us agree that the efforts involved in avoiding harm to non-customers is an appropriate cost of doing business. In principle at least, regulations induce projects to internalize the costs of such as potential externalities as public safety and environmental protection.

One of the challenges of properly allocating costs of a project is that sometimes it is not obvious how or where the external cost or benefit occurs. We are all accustomed to incorporating stakeholder needs in our projects. However, one of the difficulties of internalizing externalities is that the people affected frequently aren't recognized as stakeholders so the external costs or benefits go unrecognized until too late. At most they may be regarded as unintended consequences. However, unintended does not mean unforeseeable. Value Methodology, particularly function analysis may provide an avenue for uncovering and mitigating these consequences.

Application

As a way of exploring how VM might reveal externalities, let us consider the results of a long-standing levee project in the Midwestern US (see Figure 1). The levees protect rich farmland and were designed, built and operated over the past 50 years with close cooperation between the federal government, local levee districts and landowners.

Figure 1 Typical levee section with berms

As part of a comprehensive levee inspection conducted by this author and others, all available documentation including the design criteria, memoranda describing the designers' intent, plan sets and calculations, internal technical review comments and correspondence with stakeholders was examined in detail. The review revealed that the design included interior berms roughly 40 to 60 feet wide on both sides of the river. These wide berms were not designed to resist erosive flows but would gradually erode over an extended time. The designers performed no calculations regarding the resistance of the berms to erosion but estimated that they were wide enough to protect the levees for the 50-year life of the project. From the perspective of the recognized stakeholders this arrangement was fine. The loss of the berms also widened the channel and locally increased flood capacity providing another benefit, or so it appeared. Figure 2 illustrates a levee section where the berms have eroded away. The levee districts are now armoring the levee toes and slopes and expect to gain another several decades of service.

Figure 2. Loss of riverside levee to erosion

From the perspective of this project's stakeholders, the fate of the soil eroded from the berms is not relevant. For the landowners both upstream and downstream of the project, it is painfully relevant. Consider a mass of soil roughly 60 feet wide by 20 feet deep by 100 miles long on each side of a small river. Figure 3 is an aerial photograph of a reach downstream of the project levee depicting a dense field of sediment bars deposited in the center of the river.

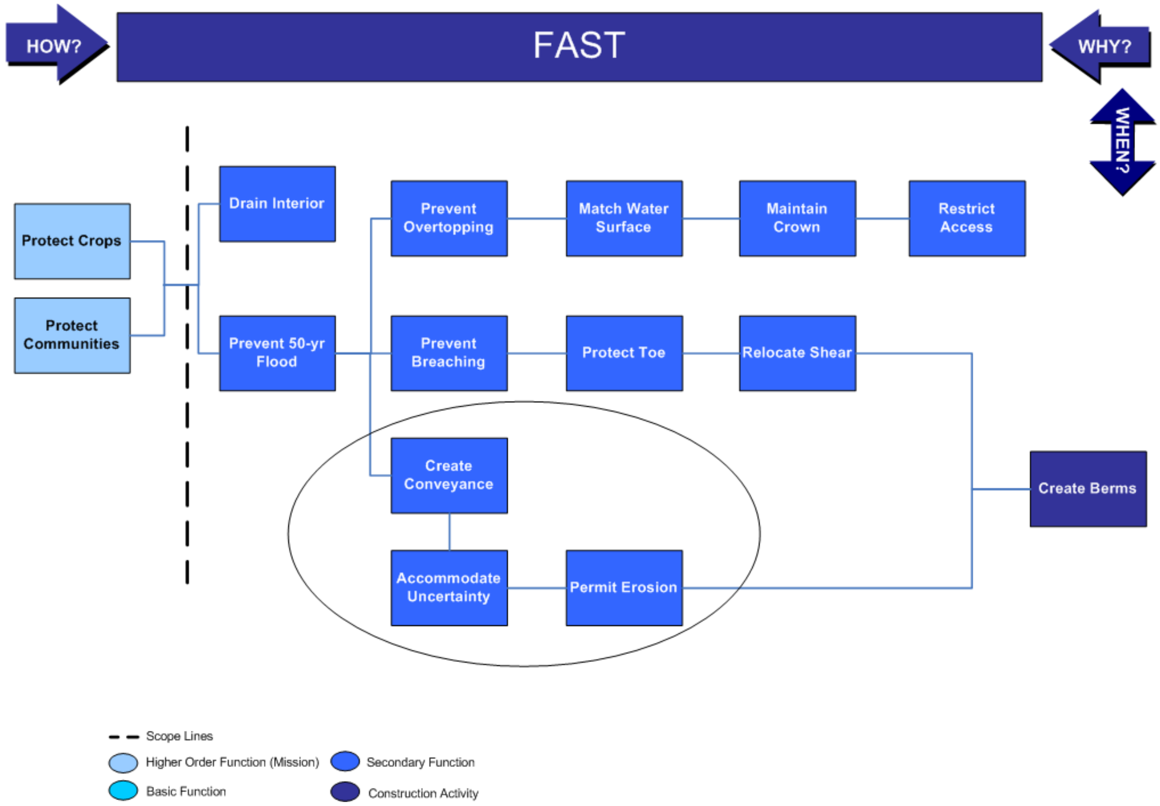
Figure 3. Sediment released from upstream berms accumulating in downstream reaches (from NRCS geodatabase)

Release of excessive sediment in slug flow during storms creates an economic externality for landowners outside of the levee district. Such large quantities of sediment can cause rivers to shift their alignment, adding acreage along one bank (positive) and subtracting it along another (negative). Along levees in the adjacent districts downstream, the excess sediment load deposited as center bars focused scouring flows at the levee toes. This accelerated erosion at the levee toes threatens their stability. Moreover, the sediment accumulates at and blocks the outfalls of agricultural field drains (see Figure 4) and unless found and cleared away, delays crop planting imposing a further burden. On a less proximate scale, both the sediment and the agricultural chemicals it carries add to the cost and complexity of processing drinking water from downstream intakes. Upstream of the project reach, the loss of the internal berms has over-widened the river channel and generated a wave of upstream-migrating incision in the channel bottom for many miles upstream.

Figure 4. Field drainage outfalls blocked by sediment deposition

Viewed through the stakeholder lens, this 50-year old project has accomplished its objective. The designers and operators of this levee system were clearly and appropriately focused on meeting the needs of those who would help pay for and benefit from the project. The question of who outside of the project might be damaged or might derive unwarranted benefit simply never came up. No regulatory agency pointed out the damages at the time and it is likely that even today the problems with the berm design would escape scrutiny by regulators. The berms were not called out as "sacrificial" on the plan sets; that was only apparent from correspondence and the design memoranda.

This levee system was never subject to a VM study and it is possible that had one been performed, the externalities would not have been discovered. However, function analysis might provide a framework for more systematic examination of external consequences. Below is a FAST diagram for this project. The functions are based on review of the project documentation, physical inspection of the project and interviews with stakeholders and operators. The project was designed before computer-based hydraulic modeling was widely used and the designers had to contend with more uncertainty regarding water surface elevations and flows than their counterparts do today. Consequently the design included an oversized channel with interior berms whose fate was ambiguous.



Function analysis provides startling clarity. The sparse language and architecture of FAST diagrams sometimes encompass explicit revelation of implicit assumptions. The circled area of the FAST diagram encloses the functions that are most relevant to the externality. In a minor process variation the team leader could ask regarding a function, "What happens when…?" This is distinct from the familiar "When" function commonly generated during function analysis. Such functions generally focus on actions affecting the project and stakeholders. Instead the team leader uses the "What happens when… " question to prompt the team members to think outside the project boundaries and beyond the population regarded as stakeholders. In this instance a VE team with expertise in river channel and levee design would generate several answers to "What happens when we permit erosion, relocate shear or create berm?" On other projects the prompts might be "What happens to surrounding communities when we increase traffic throughput? or, "What happens to groundwater supplies when we dewater the mine? or "What happens to invasive species migration when we create connections in waterways?".

Once these externalities are defined, the team can brainstorm ideas to prevent the damage, or if that is not possible, add the cost of repair and mitigation to the project budget. In the case of the levee berms, the economic implications of the release of sediment from the levee berms are straightforward and significant. Had this question been raised during project design, simple and relatively inexpensive modifications to the design such as intermittent hard points would have dramatically decreased the erosion. The next levee district downstream successfully used this approach. In this and possibly many other cases, the negative effects borne by the project's neighbors could have been entirely avoided at minimal cost had the design team understood the externalities. None of us want to add costs to our projects; however, economic externalities are real costs. They will be borne by someone. They should be borne by those who willingly benefit from the project.

Conclusion

Systematically searching for unstated and unintended consequences is difficult for both designers and VM team members. We are challenged to rethink the nature of value and the value of nature. In doing so we require another skill in addition to the usual technical and communication abilities we demand of our team members. If our team members and we can broaden our gaze to larger spatial and temporal scales than the strict confines of our project boundaries we can avoid unintentional harm to others while still meeting our own needs. Value Methodology's unique ability to reveal the essential elements of a project in the starkest of terms may be an invaluable tool to improve the sustainability of our work.

References

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