



Synthesis, part of a Special Feature on [Exploring Opportunities for Advancing Collaborative Adaptive Management \(CAM\): Integrating Experience and Practice](#)

Truths and governance for adaptive management

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ABSTRACT. Managing large-scale water resources and ecosystem projects is a never ending job, and success should be measured in terms of achieving desired project performance and not just meeting prescriptive requirements of planning and constructing a project simply on time and within budget. Success is more than studying, planning, designing, or operating projects. It is developing the right plan, getting it implemented, and seeing that it is operated and performs properly. Success requires all of these, and failing any of these results in wasted resources and potential for doing great harm.

Adaptive management can help make success possible by providing a means for solving the most complex problems, answering unanswered questions, and, in general, reducing uncertainty. Uncertainties are the greatest threats to project success. Stakeholder support and political will are ultimately essential in achieving project success. Project success is often impossible to achieve if uncertainties persist. Resolving uncertainties quickly and efficiently facilitates the greatest forward progress in the shortest possible time.

Uncertainties must be reduced or resolved to a sufficient level, not over-resolved or under-resolved. Over-resolving presents a value trade-off between additional knowledge and the cost of getting it. Under-resolving trades greater risks of failure for cost savings. Resolitional sufficiency varies from uncertainty to uncertainty, and applying risk-based logic is helpful in determining what is sufficient.

Adaptive management can bring great efficiency and produce high returns on investment. Project-stopping uncertainties get resolved, and resources are spent wisely. Organizational governance must understand adaptive management and value it. Adequate time and money must be provided. Adaptive management must be integrated into other organizational processes such as project management and project delivery. Integrating adaptive management requires a new mind-set, individually and organizationally. The resources provided must be scaled, oriented, and tuned to meet the challenges being addressed.

Key Words: *adaptive management; ecosystem restoration; governance; implementation; integrating risk and uncertainty; performance; project management; resolitional sufficiency; resolving uncertainties; risk management; stakeholders; success; uncertainty*

INTRODUCTION

In the past decade or so, there has been an explosion of the use of adaptive management, at least the term if not the method. The term has reached buzzword status. As organizations have embraced adaptive management, different definitions and versions have emerged (Williams et al. 2009, RECOVER 2010). Some of these embraces are organizationally top down, and some are bottom up; some are enthusiastic and well founded, and some are lukewarm and ill informed. Whether well applied or not, these variations are informing many viewpoints as to the effectiveness of adaptive management. A number of investigators have evaluated the success or failure of efforts to apply or claims of applying adaptive management (Walters 1997). Perhaps more importantly, managers and executives perceive the value of and consider the applicability of adaptive management from their perception of its effectiveness to cost effectively help solve problems they care about. This ultimately affects the degree to which they are willing to support and fund adaptive management.

The application of adaptive management can be challenging for a variety of reasons, some of which I explore. Problems to which adaptive management has been applied are often very complex and complicated. Misapplication or simply poor deployment of adaptive management will not help solve problems but may lower perceptions that adaptive management is helpful. These cases are not useful for assessing the effectiveness of adaptive management; however, they may be useful in demonstrating the importance of

properly applying adaptive management. This has led to debate as to when adaptive management is being well deployed, what some have termed as true adaptive management, or conversely, pretend adaptive management when it is not (Marmorek et al. 2007). It follows that the debate must define what adaptive management is and is not. Although this may be the crux of the debate, it is useful to consider the practice of adaptive management and what helps solve problems. In my view and in adaptive management terms, solving problems means answering unanswered questions and reducing uncertainty such that planning, engineering, design, and operations of projects can proceed in an orderly fashion that ensures that goals and objectives are met and unintended negative impacts are avoided.

My views are based primarily on my personal experience in applying adaptive management to large-scale water resources and ecosystem restoration projects over the past 25 years (Loftin et al. 1990, RECOVER 2010). Examples and insights have come from a number of assignments involving the application of adaptive management and other project implementation processes. These assignments include the Kissimmee River Restoration, Everglades Restoration, Louisiana Coastal Restoration, Lower Columbia River Ecosystem Restoration, and Platte River Restoration projects as well as others. This project experience has provided a wealth of lessons learned, underscoring what works and what does not. I present my personal perspective as a synthesis of how adaptive management can play a critical

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role in complicated and complex projects through better integration of adaptive management throughout project processes.

These assignments have allowed me to work closely with scientists, i.e., biologist and ecologists, and come to a keen appreciation of their challenges and methods. As a water resources engineer, I have worked as a hydrologist, modeler, designer, planner, operator, and project manager while employed in government resource agencies and as a private consultant to the government. These different roles have each broadened my perspectives on what works and what does not. Over time, experience has distilled for me that making a difference, in the end, is not about simply studying, planning, designing, or operating projects, but about developing the right plan, getting it implemented, and seeing that it is operated and performs properly. Failing any of these will largely result in wasted resources and potential for doing great harm.

SUCCESS AND FAILURE

Because large-scale water resources and ecosystem restoration projects are so complex and are often complicated by related factors such as changes in land use, population, societal desires, and so forth, and their performance is driven by climate, hydrology, geomorphology, and other factors, it is important to realize that once humans modify or otherwise attempt to control parts of a complex watershed and ecosystem, the work is never complete and involvement never ends. Therefore, it is imperative that any such project undertaking recognize this and not limit its commitment to a poorly founded plan that provides benefits to some while externalizing impacts to others or produces benefits at one scale only to court disaster at another scale. Likewise, project cost accounting should not be limited to first costs and traditional operation and maintenance costs but should include the commitment to monitor, evaluate, adjust, modify, and make improvements to the project over its life cycle to manage its effects in the watershed and ecosystem. Today, the heirs of dilapidated dams and silt-filled reservoirs wish the builders had been required to account for end-of-life costs and set aside funds to remove the dams and restore the rivers when the benefit stream dried up.

The view of earlier days that a project could be built and then largely ignored except for traditional operations and maintenance implied that project implementers could perfectly predict project effects and that external factors that could affect project performance were static. We have learned through experience and at great cost that this view is faulty, must be abandoned, and should be replaced by a view and understanding that to deliver desired benefits and minimize harmful impacts, continuous review of project performance and management of performance must be integrated along with traditional operations and maintenance.

It is helpful to view success and failure less as discrete outcomes and more as two sides of a continuous spectrum where something is either failing or succeeding, and this status can change over time. Essentially, consider success and failure as the positive and negative zones of a gauge whose indicator needle reports current status. Tracing this status over time will provide a history curve because forecasting future project performance predicts future status. More success and earlier success will produce greater positive area under this curve. Failings will produce negative area.

Together, using whatever units apply, the net cumulative area provides more insight into success and failure. Like the time value of money, the time value of cumulative success and the negative time value of failure represent the returns or debts generated by a project.

Therefore, discovering problems, uncertainties, and unanswered questions quickly and efficiently and addressing and resolving them, with an effective and efficient process, will provide the greatest forward progress in the shortest possible time. This will maximize the time value of success and minimize the negative time value of failure. If applied properly, adaptive management can provide this effective and efficient process to a wide range of problems.

For my purposes, problems are issues or concerns raised by stakeholders. Resolution of problems by project initiatives is measured in terms of success in implementing a new project or effecting a positive change in an existing project. Success of a new project or positive change in an existing project means that actual implementation occurs and results in production of more or the most desired benefits while harmful impacts are reduced or eliminated. This is in contrast to failure, which can be measured in terms of lack of implementing positive change resulting in continued delivery of inferior benefits and harmful impacts.

In my experience, there are always many reasons for failure, but many failures seem attributable to the lack of understanding in the political and/or social sectors and a corresponding lack of will to take decisive actions. When one or more uncertainties are left unresolved, decision makers, stakeholders, and the public may not understand linkages between action or inaction and the resultant outcomes. Failure to understand these linkages can erode political and/or social will to take action. Unfortunately, there is a common misconception that inaction equals no impact. There are always impacts, positive or negative.

RESOLVING UNCERTAINTIES

Uncertainties are unanswered questions, questions that do not yet have an acceptable answer. In adaptive management, we use the term uncertainty, and this term will be used primarily for the remainder of this discussion. In my experience, uncertainties are the greatest threats to project success. Although stakeholder support and political will are ultimately essential, these are often impossible to achieve if uncertainties persist.

This has led me to a more pragmatic view of uncertainties associated with projects and the resolution of them. Uncertainty, in terms of preventing project success, can be any unanswered question that makes it easy for certain stakeholders to protest that moving forward may cause more harm than benefit. Political will to approve and implement a project withers if there is too much uncertainty. Uncertainty, viewed this way, is not necessarily tied to a single technical discipline. Often, this kind of project-stopping uncertainty can be expressed in more general forms such as the following: "How can stakeholders be assured no calamity will come their way?" "How will it be funded?" "How much will it cost?" "How can we be sure we will not lose a big lawsuit?" Additionally, there can be uncertainty that is clearly focused in a technical discipline and may take the form of two or more competing hypotheses capturing the uncertainty, for example, how plant succession may proceed.

If a project is to be successfully implemented, all important uncertainties must be resolved. I use resolved as a relative term to mean appropriate level of resolution. Resolving an uncertainty usually requires acquiring and applying some new knowledge or discovering and applying existing knowledge to close knowledge gaps. This is part of the learning process integral to adaptive management. Perfect or complete knowledge indicates that 100% resolution of an uncertainty has been achieved. This is rarely possible and is usually not warranted. Additionally, there is a trade-off between the value of additional knowledge and the cost of getting it. The sufficient level of resolution may vary from uncertainty to uncertainty; however, much less than 100% will often suffice to reduce or resolve uncertainty to an acceptable level as viewed by the project's stakeholders and decision makers.

How can one determine when sufficient resolution is reached? For uncertainties that lie in scientific and engineering disciplines, statistical methods can be employed to establish confidence limits and otherwise help investigators determine when uncertainty has been resolved sufficiently. These metrics can be used to explain and convince nontechnical stakeholders that an uncertainty has been resolved sufficiently. For uncertainties that lie in less technical areas, a number of less direct measurements or assessments can be employed to determine when sufficient resolution has been reached. These can include results from public meetings, public comments, views expressed at interagency meetings, opinion surveys, interviews, consensus seeking, and decision science tools such as multiple criteria decision analysis, and so forth, applied as necessary and appropriate. For uncertainties that lie in legal or policy areas, a new interpretation, a clarification, or a new or amended law or statute may be the sufficient resolution. Whatever the uncertainty, it is important to determine what will constitute sufficient resolution for the purposes of successful project implementation and operations. Not doing this puts at risk the project's success as well as the expenditure of resources dedicated to that purpose.

GOVERNANCE

To be successful, adaptive management must be applied under and supported by a governance structure that understands adaptive management, values it, and is willing to commit the necessary resources to allow its processes to work. This means adequate time and money as well as integrating it into other project management and project delivery processes that exist within the organization. A few of the critical processes are further discussed subsequently.

Adaptive management and risk management

When considering the potential of success or failure from a risk-based perspective, risk is defined as the product of the probability of failure and the magnitude, measured by some appropriate metric, of the consequence of that failure if it occurs. This is helpful when establishing what constitutes sufficient resolution of an uncertainty. As mentioned previously, 100% resolution is rarely appropriate even if possible. When either or both the probability of failure or the consequence of failure is low or very low, the needed degree of resolution is also low. Likewise, when the probability and/or consequence is high or very high, the needed degree of resolution is high. In my experience, this risk-based logic is not often applied in adaptive management. Too often, a high degree of resolution is sought as a matter of course,

and this may yield little return on the effort with respect to the buy down of risk. Similarly, when an uncertainty is not identified and therefore not addressed or resolved at all, or is identified but not resolved sufficiently, the risks are not controlled.

In my experience, many versed in risk management are not very knowledgeable about adaptive management. Risk assessments are often viewed more like a detached diagnosis or tag of some sort than a factor in the sufficient resolution of an uncertainty as part of the overall problem-solving effort.

In keeping with the previous discussion of failure, there are two types of risks: the risks that potentially affect the implementation of the project and mostly focus on the implementation processes, and the other risks that potentially affect the performance of an implemented project. From a risk management point of view, both are valid risks. However, I generally see much more focus of risk management applied to the former and less to the latter. I see the application of adaptive management generally more often focused on the latter.

Adaptive management and risk management are powerful tools in guarding against project failures. The risk management approach identifies and assesses risks and may identify ways to mitigate risks; however, it does not often provide integral to its approach innovative problem-solving strategies that can mitigate risks when no apparent mitigation is initially identifiable. Conversely, adaptive management fully integrates processes to reduce risks by resolving uncertainties, discovering and applying appropriate knowledge, and developing new knowledge and feeding this back into the process so that implementation can proceed and performance can be improved.

Adaptive management should integrate the concepts of risk management where they can be used to help establish the sufficient level of resolution of each uncertainty. In my experience, adaptive management is more capable of addressing and solving problems holistically than risk management can, especially when no ready-made solutions exist. Risk management efforts can inform adaptive management efforts more than adaptive management efforts can inform risk management efforts. Therefore, it is my belief that risk management should be incorporated under the broader umbrella of adaptive management.

Adaptive management and project management

Unfortunately, adaptive management is often viewed as unnecessary, too costly, too time consuming, and so forth by some project team members not directly involved in the adaptive management effort and by some managers and stakeholders. The value of properly applied adaptive management should be understood and highly valued by all involved in the project. When applied properly, adaptive management will bring great efficiency and produce high returns to the project. It will help ensure that project-stopping uncertainties are resolved and that by abiding by the sufficient resolution principle, resources will be spent wisely. Together, this will help ensure project success by reducing the risks of inaction and poor performance.

Project management is a well-developed discipline focused on delivering projects or products within predetermined schedules and budgets. Additionally, project managers are tasked with delivering the project or product as required or specified. This can be thought of as the scope in the trilogy of project management:

schedule, budget, and scope. In the construction of buildings, airplanes, or other complex human-built things, the specifications are normally very explicit, and as long as industry standards, building codes, and so forth are followed, the outcome is predictable with great certainty. In ecosystem restoration, with exception of the constructed or deconstructed components, there are few specifications and industry standards that make outcomes predictable. Therefore, considerable uncertainty can exist as to the design, performance, and success of ecosystem restoration projects. Although this is true, project management practices for ecosystem restoration projects typically apply standard levels of rigor to schedule and budget but simply do not have the information necessary in terms of explicit specifications to control the scope of these projects as they do in other types of projects. This greatly affects project managers' abilities to predictably and consistently deliver ecosystem restoration projects on schedule and within budget that will perform as intended. This is not a fault of project managers or even their organization, but rather the nature and complexity of these projects, underscored by their attendant uncertainties.

Managers and their organizations must ensure that adaptive management becomes an integral part of project management as well as other project delivery disciplines and that the rigor of project management be used to allow adaptive management to help deliver high-quality projects. To accomplish this, project management must treat each uncertainty as a task belonging to the overall project management plan, work breakdown structure, and schedule. Each task or uncertainty will have a work plan, a schedule, and budget. The work plan is the key to resolving the uncertainty. The work plan will describe with appropriate detail a strategy for sufficiently resolving the uncertainty. It will document what is known and not known about the uncertainty and what needs to be done to close the knowledge gap or otherwise resolve the uncertainty. It will also specify who is responsible for, who will lead, and who will perform the necessary actions to achieve the resolution. Additionally, it will contain the schedule and budget for the effort. In essence, the work plan is a scope or statement of work that will direct the effort to resolve the uncertainty. In keeping with good project management practices, frequent status checks should be conducted, progress noted, and course corrections executed as necessary. If there is lack of progress, correcting efforts must be instigated and followed up. As with work in other disciplines, good project management brings accountability to adaptive management efforts. This will strengthen the adaptive management program and earn the respect of those critical of it.

Adaptive management and project life cycle

Achieving success during the planning and implementation portion of a project as well as during its operational life span is critical. As stated previously, in the past, there has been a tendency to limit commitment after project implementation to traditional operations and maintenance. This means water control operations of spillways, pumps, turbines, and so forth in accordance with an operational plan that was probably developed when the project was designed. Additionally, traditional maintenance means that the constructed features and facilities will be oiled, lubricated, painted, repaired, replaced, and so forth in accordance with some schedule or as needed. Too often, the project's effects are not addressed in any similar, comprehensive,

or meaningful manner. If the project's beneficiaries believe they are not receiving the intended benefits, they may demand review and modifications. If other stakeholders believe they are adversely affected by harmful impacts, they may demand review and modifications.

The shortcomings of the traditional approach are that problems have to grow and impacts have to accumulate to a high enough level that someone takes notice and complains, and then more time has to elapse until someone in authority is convinced to do something about it. During this time, opportunities to fix the problems can evaporate, the problems usually become worse and more difficult to fix, and the impacts accumulate.

Acknowledging this and accepting that no project functions perfectly underscores the value of adaptive management across the project's life cycle, supporting integration of it into the long-term operations and maintenance program. This would provide long-term monitoring of benefits and potentially harmful impacts, like a report card on the project's performance throughout the project's life span. Most business endeavors include such reporting, and most investors and business owners would not consider risking their resources on a business that did not track its performance with the intent to intervene at an early stage if problems emerge. It is amazing that the same sound business sense is not often applied to major water resources projects. There is movement to do this in ecosystem restoration projects, but there is much grumbling about the cost of monitoring.

In addition to the preceding discussion, there are other reasons to apply adaptive management after implementation. Uncertainties that emerge during project planning and development simply cannot be resolved until some or the entire project is implemented and trial operations are conducted. These are like experiments on the entire prototype and cannot meet the controls required by the scientific method. This is the only way to resolve some uncertainties. Even after a period of testing, it is wise to continue monitoring to be receptive of signals or early warnings that things may not be performing as expected.

More on governance

Any organization that commits to use adaptive management should also consider how it will cause adaptive management to be used. As mentioned in the introduction, the term adaptive management has reached buzzword status. Applying adaptive management is challenging and requires significant organizational commitment. Too often, a few enthusiastic staffers are assigned the responsibilities to "do adaptive management" and then organizationally removed from the mainstream of the organization's work flow or project processes.

As argued previously, adaptive management should be integrated with project management, risk management, and other organizational processes. Additionally, adaptive management should be incorporated across disciplines to bring its powerful problem-solving methods to bear on all uncertainties that put at risk project success.

Some practitioners believe adaptive management is solely for scientific uncertainties and must include rigorous experimentation using the scientific method. I agree that it is for this purpose but add that such a powerful problem-solving method should be used

wherever it can be effective, especially in multidisciplinary organizations. I believe that the better staffers and managers from all disciplines understand and use adaptive management, the better chance it will be applied successfully in the scientific arena as well as in the other disciplines.

In water resources and ecosystem restoration projects, although scientific uncertainties may be the most apparent or noted uncertainties that can stop or derail a project, most of these projects will require engineered solutions, including constructed components, modification of existing ones, or changes and water control operations. Uncertainties in the design or modification of engineering components can be resolved by adaptive management.

Any discipline represented on project teams may have uncertainties that need to be resolved but cannot be resolved by experimentation. These may include the policy, planning, and legal disciplines (Holling 1978). In these areas, uncertainties often manifest themselves in terms of describing what is possible or not possible, at least based on understandings at that moment. Sometimes the understanding of a policy or legal issue may be viewed as an ironclad constraint; however, something viewed as a constraint can be restated as an uncertainty, which can be resolved to a new understanding. Through a more integrated approach, current understandings of a policy or legal issue may be probed or questioned, leading to new and helpful interpretations of existing policy or law. In other instances, this can lead to changes in policy or law to allow the project to be implemented and succeed. Too often, good technical work ends at a roadblock of policy or law that could have been overcome if the policy or legal issues had received adequate focus earlier in the project. I am an advocate of applying the powerful methods of adaptive management to all uncertainties that put at risk the project's implementation and success. All uncertainties should be processed through rigorous project management as described previously to yield sufficient resolutions in time to facilitate implementation of the project. Management must understand this and be committed to ensuring that governance is in place that will require and support this.

Organizations engaged in developing or operating complex projects face a challenge of integrating members of an interdisciplinary team. Too often, the specialists in one discipline are not well versed in the challenges faced in other disciplines; however, each has their uncertainties that put project success at risk. Applying the adaptive management process across all disciplines helps ensure that it is integrated into risk management and project management and weaves a common thread throughout the project team and forces the team to think collectively about identifying and resolving uncertainties that threaten project success. The toughest problems are often interdisciplinary, and traditional organization by disciplines makes it difficult to solve these problems. The organizations that recognize and support integration of disciplines will be more successful in their project endeavors.

Organizations applying adaptive management must fully engage their stakeholders. Stakeholders are the source for discovering uncertainties and helping the organization understand what constitutes sufficient resolution. For stakeholders to be able to provide maximum value and help the project process rather than

disrupting it, they must be educated in the adaptive management process. They do not need to become experts, but they need to understand why the process proceeds as it does. In my experience, when stakeholders are afforded appropriate training, they support adaptive management. Some may have suspicions that testing, learning, and feedback loops are code for perpetual experimentation, but if explained properly, it has almost universal appeal from small business owners, farmers, fishers, and local officials. They all use some variation of the process in their own occupations. They will become watchdogs to ensure that the process is followed and that resources are not wasted, stopping or curtailing effort when sufficient resolution is reached. Additionally, they will police each other and limit unreasonable assertions that the organization's staff is going too far or hasn't gone far enough. Use stakeholders as a barometer of resolution. Their feedback is one of the best gauges for determining when uncertainty has been reduced sufficiently. After all, if educated stakeholders fully support project efforts, it will be easier to gain the political will necessary to implement the project, and if they do not fully support the project, political will may be elusive.

Organizational governance must include an ethos to look at the full costs of projects and take the longest view of their financial responsibilities. Building a project that does not perform well and produces huge legal costs is certainly not in an organization's long-term interests. Externalizing some of the true costs as harmful impacts to others will eventually be tallied against the project and the organizations responsible for it.

Until recently, adaptive management has grown from mostly bottom-up support and advocacy. More recently, there is top-down support and advocacy. In many cases, these two approaches are not present in the same organization. To move adaptive management from its weak or mixed standing in many organizations to a level where its full potential can be realized, organizational governance must be established that will require and support the full integration of adaptive management in the planning, development, implementation, and operational phases of its project efforts. The commitment of organizations to apply adaptive management and to follow through on decision making must be deeply ingrained in their commitment to their projects, the adaptive management program, and their mission.

CONCLUSIONS

I have shared a number of truths about applying adaptive management. In most instances where I have observed adaptive management being contemplated or applied, the efforts and the organizational commitment do not match the scales of the problems being addressed. It seems that within certain functional areas of the leading organization, the lack of knowledge and experience in applying adaptive management plays a role in how effective its application can be. In my view, applying adaptive management requires an entire shift in mind-set, individually and organizationally, to one that is scaled, oriented, and tuned to meet the challenges being addressed.

The challenges most projects face are not limited to the scientific arena but exist in most disciplines involved in the project undertaking. Other processes such as risk management and project management that are employed in project delivery can benefit from integration of adaptive management, and adaptive management can benefit from integration with them.

Managing large-scale water resources and ecosystem projects is a never-ending job. Success should be measured in terms of achieving desired project performance and not just meeting prescriptive requirements of planning and constructing a project simply on time and within budget.

When all the jargon is stripped away from adaptive management, it is a very intuitive, business savvy approach for navigating through complex challenges that have many unknowns and uncertainties. Stakeholders understand this when it is presented in this way and appreciate and will support what those applying adaptive management are trying to accomplish.

All uncertainties must be sufficiently resolved, not over-resolved or under-resolved. Adhering to this principle does not always satisfy every purpose; however, it is the most efficient and effective way to retire uncertainties that put project success at risk and allow the project process to move forward, opportunities to be seized, benefits to be delivered, and harmful impacts to be stemmed.

Responses to this article can be read online at:
<http://www.ecologyandsociety.org/issues/responses.php/6353>

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