GUIDE TO THE RESILIENCE DIVIDEND VALUATION MODEL

Craig A. Bond, Aaron Strong, Nicholas Burger, and Sarah Weilant

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Preface

Policymakers, program practitioners, and investors who want to achieve the greatest possible benefits from the resilience projects that they support lack effective tools to estimate the net benefits those projects provide relative to alternatives. The RAND Corporation and the Rockefeller Foundation formed a partnership to develop a modeling framework that can be used in a decision analysis environment, providing a structured way to think about the benefits and costs of projects developed with a resilience lens. We developed the Resilience Dividend Valuation Model (RDVM) to help practitioners evaluate resilience outcomes by quantifying the resilience dividend. This guide complements the more detailed report on the RDVM [*Resilience Dividend Valuation Model: Framework Development and Initial Case Studies*], and it walks through how the RDVM can be applied by individuals and communities to assess and evaluate resilience investments. This work was supported by the Rockefeller Foundation.

RAND Infrastructure Resilience and Environmental Policy

The research reported here was conducted in the RAND Infrastructure Resilience and Environmental Policy program, which performs analyses on urbanization and other stresses. This includes research on infrastructure development; infrastructure financing; energy policy; urban planning and the role of public–private partnerships; transportation policy; climate response, mitigation, and adaptation; environmental sustainability; and water resource management and coastal protection. Program research is supported by government agencies, foundations, and the private sector.

This program is part of RAND Justice, Infrastructure, and Environment, a division of the RAND Corporation dedicated to improving policy and decisionmaking in a wide range of policy domains, including civil and criminal justice, infrastructure protection and homeland security, transportation and energy policy, and environmental and natural resource policy.

Questions or comments about this report should be sent to the co-project leaders, Craig Bond (Craig_Bond@rand.org) or Aaron Strong (Aaron_Strong@rand.org). For more information about RAND Infrastructure Resilience and Environmental Policy, see www.rand.org/jie/irep or contact the director at irep@rand.org.

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SECTION 1

Background and Rationale

RAND and the Rockefeller Foundation formed a partnership to develop the Resilience Dividend Valuation Model (RDVM), a modeling framework that can be used to support decisionmaking about resilience investments by quantifying a *resilience dividend*. For this work, the resilience dividend is the difference in net benefits to society between a resilience project and business as usual (BAU) (Rodin, 2014).[1] The benefits are typically related to the ability of "people to better withstand disruption in the future, to improve current situations, and/or to positively change the trajectory of a place and/or people's lives."[2]

To put a finer point on it, the resilience dividend can be defined as the difference in the stream of net benefits to a society's well-being between resilience projects and a counterfactual setting, which can be either a BAU case or a project that is not developed with a resilience lens. While resilience dividend benefits often involve recovering from a particular shock or withstanding a stressor, a resilience project can have other benefits as well. Our broader interpretation of the dividend is more inclusive.

Valuing these additional benefits from a resilience project requires that we understand how resilience policy and program interventions change the valuable elements of any given system over time—through providing resources, relaxing constraints, or increasing opportunities to stakeholders—and apply the means of monetizing these changes. Of particular importance is the consideration of the linkages between elements of a system and how the system structure can be leveraged to create additional co-benefits.

Our working definition of *resilience* is the capacity of a system—a household, a community, an organization, or a coupled natural-human system—to prepare for disruptions from outside of the system, to recover from shocks and stresses, and to adapt and grow from a disruptive experience.

A *resilience project* is defined as an intervention that, at least in part, seeks to improve the ability to manage, respond to, or recover from a shock or stress that might result in a loss of well-being, and that has the potential to produce other benefits not directly related to the shock or stressor. This latter concept—often termed the "co-benefits" associated with the resilience project—is a key part of what distinguishes a resilience project from an intervention that focuses solely on disaster risk recovery outcomes. In particular, what might be termed a *resilience lens* is a view that approaches project development and investment strategies in a way that takes into account system properties and addresses both the risk of loss from a shock or stressor and the resulting co-benefits the project or investment produces.

From an economic standpoint, good decisionmaking requires prioritizing feasible projects with the greatest total net benefits. Failure to fully take resilience dividend benefits into account will underestimate the total value

1 Rodin, J. (2014). *The Resilience Dividend: Being Strong in a World Where Things Go Wrong*, Public Affairs, New York.

2 This language was taken from documents provided to the RAND research team by the Rockefeller Foundation.

of a project, perhaps leading to suboptimal decisions. Even if the dividend cannot be explicitly valued (due to, e.g., data limitations), qualitative information about these benefits might be useful in describing project outcomes and choosing among competing courses of action.

Objectives of This Guide

This document provides a guide to the RDVM that was developed as part of this research. The RDVM is a modeling framework designed to help analysts and practitioners estimate the realized or potential resilience dividend from a project. Based on the inclusive wealth theory, the RDVM is a dynamic, systems-based approach that maps changes in the flow of goods and services from a resilience project into changes in well-being, and provides guidance on the data needed to estimate the resilience dividend. The model provides the theoretical and empirical basis for estimating the dividend over a range of projects, settings, and scales. RDVM, which combines elements of project evaluation and economic valuation, can be used to guide thinking about the probable outcomes of resilience investments and how valuable these outcomes might be to stakeholders that operate within the system.

This guide is intended for use by practitioners, analysts, and researchers to understand how to conceptualize particular systems and interventions in a structural economic framework, and how to use this information to plan data collection and modeling efforts for estimating parts of the resilience dividend. The value of the model is in thinking critically about how a particular intervention will change consumptive or productive activities within the system (quite possibly through enabling different behaviors), and how these outputs and outcomes can be monetized—in theory and in practice.

While the RDVM is based on the theory of inclusive wealth, which represents the value of a system through the social value of a system's capital assets, we do not use the model to explicitly estimate system wealth. Rather, the conceptual structure of inclusive wealth, in which goods and services contribute to human well-being and are produced through a combination of capital stocks and technology in a dynamic context, is used to help understand and illustrate the causal relationships between system elements. Additionally, the approach can also generate hypotheses that might be tested for any given project. As such, the RDVM provides the "roadmap" for what might happen with a resilience project/intervention, and guidance for data collection and monetization of the net benefits (or costs) of project results versus an assumed counterfactual.

Because the resilience concept is complex and systems are context-specific and dynamic, ***the RVDM is not a black box nor a "plug-and-play" tool***. Rather, it is a flexible approach that helps users think about interventions in a structured, systems-focused way, and it guides users in how to use data to provide evidence of the dividend. In some cases, it may only be feasible to estimate a *partial* resilience dividend, while in other cases—particularly those with more data available—a full estimate may be more feasible.

The advantages of this model over others include:

- an explicit link to project-related resilience benefits;
- a way to identify and measure changed behaviors; and
- The guidance it provides in terms of modeling, data collection, and estimation.

Our hope is that the model is useful for practitioners to provide evidence of a resilience dividend after a project's completion, and for decisionmakers evaluating potential projects.

Organization of This Guide

Section 2 provides a brief overview of the theory of inclusive wealth, which shows how system elements are conceptualized, discusses the evolution of the system over time, and discusses how the conceptualization allows for a formal representation of the resilience dividend. We also discuss the major empirical challenges and the relationship with dynamic project evaluation. It is designed to provide a quick overview of the major elements of the RDVM.

Section 3 provides additional details and walks through major case archetypes. It is intended to help practitioners conceptualize and map their own systems of interest, including the capital stocks, flows of goods and services, allocation mechanisms, and measures of social welfare.

Section 4 provides a step-by-step walkthrough of how to apply the RDVM. It is not a toolkit, per se, but rather guidance for using structured, causal thinking to generate hypotheses about the elements of the potential resilience dividend that can be tested with data or simulated with other types of models. While complex, we maintain that systemically thinking about the relationships between system elements and how project interventions might change underlying behavior provides practical guidance for data collection efforts and estimating elements of the dividend.

Section 5 discusses skills that might be useful when applying the RVDM, some real-world issues in dealing with the limitations of data in the context of the conceptual model, and some alternatives for generating evidence for or against the existence of a resilience dividend in particularly challenging data environments.

SECTION 2

Motivating the Resilience Dividend Valuation Model: Inclusive Wealth Theory

The RDVM is based on the theory of inclusive wealth.[1] Inclusive wealth theory values the capital stocks within a system, taking into account the manner in which goods and services are produced from the capital stocks and how society values those goods and services. Importantly, the linkages between capital stocks and how stakeholders respond to changes in them are explicitly incorporated in a dynamic framework. The framework does this in a flexible yet consistent manner.[2] Here, we briefly introduce the framework, with further elaboration of framework elements in Section 3. While implementing the model can be complex and data-intensive, we believe the principles that underpin the framework are useful and actionable for practitioners working with resilience investments.

Components of Inclusive Wealth

Figure 2.1 provides an example of a system with three capital stocks and two goods and services that stakeholders value. The arrows from the blue capital stock boxes to the red goods and services circles represent the production relationships in the system as well as the choice of how much of each good to produce. The figure also lays out assumptions about the components in the system that are related. We assume that good/service #1 is produced using capital stocks #1 and #2, while good/service #2 is produced using all three capital stocks. The green well-being box is connected to both goods/services, meaning we assume that society values each of these in some way.

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1 Dasgupta, P. and K.-G. Mäler (2000). "Net national product, wealth, and social well-being." *Environment and Development Economics* **5**(01): 69-93.

Dasgupta, P. (2001). "Valuing objects and evaluating policies in imperfect economies." *The Economic Journal* **111**(471): 1-29.

Arrow, K. J., et al. (2003). "Evaluating projects and assessing sustainable development in imperfect economies." *Environmental and Resource Economics* **26**(4): 647-685.

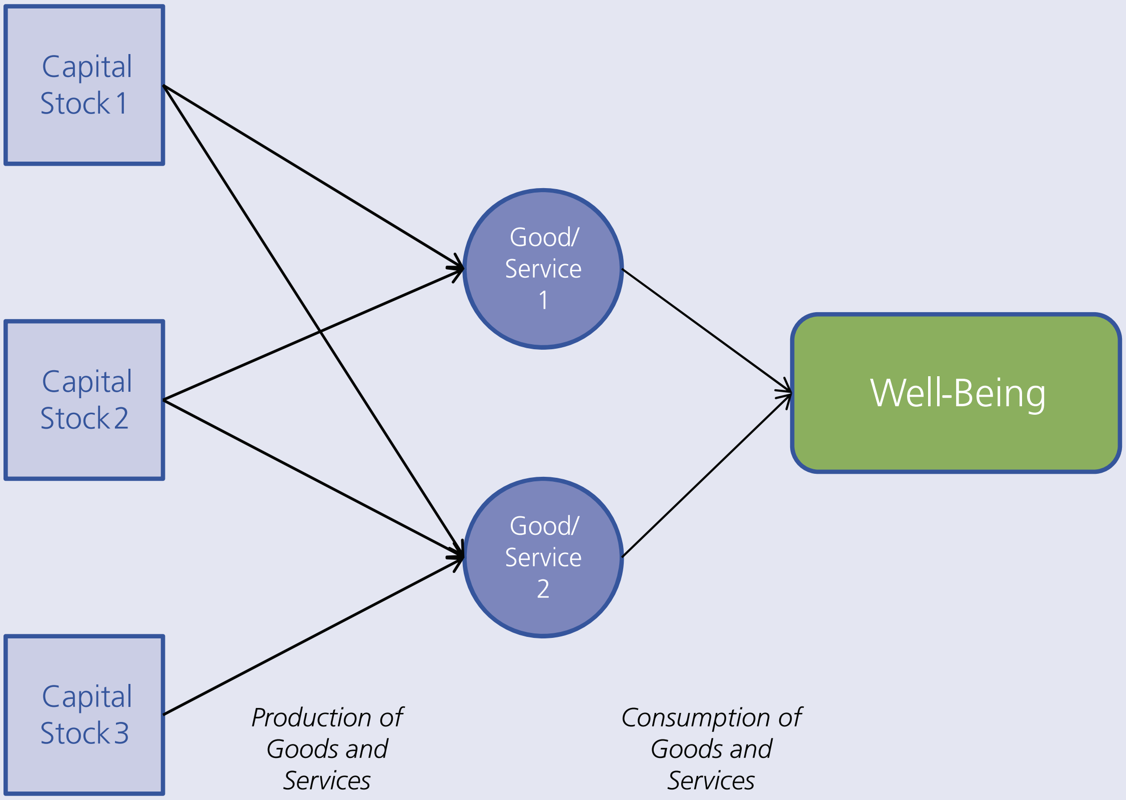
Barbier, E. B. (2013). "Wealth accounting, ecological capital and ecosystem services." *Environment and Development Economics* **18**(02): 133-161.

Fenichel, E. P. and J. K. Abbott (2014). "Natural capital: from metaphor to measurement." *Journal of the Association of Environmental and Resource Economists* **1**(1/2): 1-27.

Irwin, E. G., et al. (2016). "Welfare, Wealth, and Sustainability." *Annual Review of Resource Economics* **8**: 77-98.

2 Irwin, E. G., et al. (2016).

Figure 2.1.
Production and Consumption Relationships in an Economic System



Source: Authors' representation.

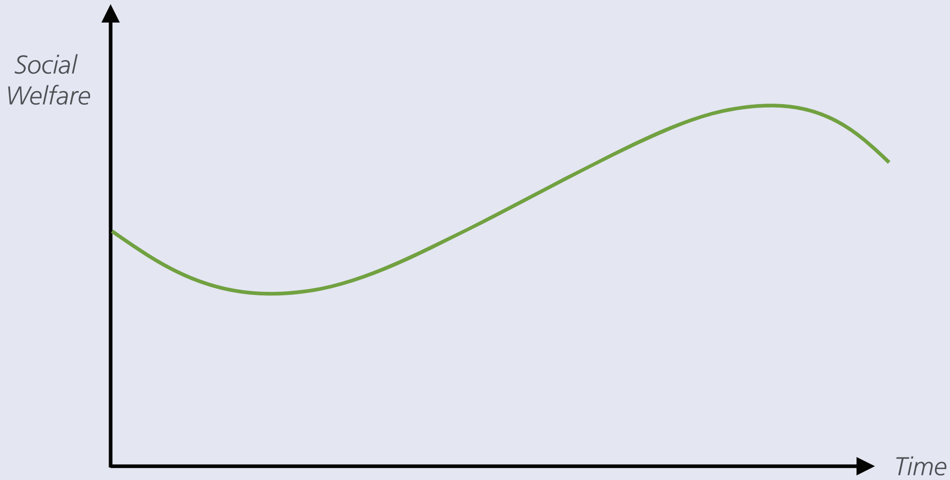
Dynamics of the System

The inclusive wealth theory is inherently *dynamic*, which means it assumes that capital stocks evolve over time through natural or human-induced processes. For example, consider an agricultural system. Land (a natural capital stock) used in the production of agricultural crops (a valuable good for farmers) can lose fertility over time. This evolution involves both natural (e.g., nutrient cycling) and human (e.g., cropping) processes that in turn affect the ability of a given plot to produce the valuable crop. Without taking additional actions (such as adding fertilizer or changing crop rotations), these dynamics will lead to decreased yields (a change in the provision of goods and services) and decreased income (a change in well-being). The human and natural processes combine to produce changes in either the quantity or quality of capital stocks.

As the capital stocks and associated flows of goods and services evolve over time, the path of well-being evolves as well (see Figure 2.2). Well-being at each point in time is measured through a social welfare (or utility) function that serves to value each of the relevant goods and services represented by the model, and aggregated across goods and services. This could include the profitability of firms or consumer surplus.[3] Well-being could be aggregated across all relevant stakeholders or calculated separately for different groups of stakeholders.

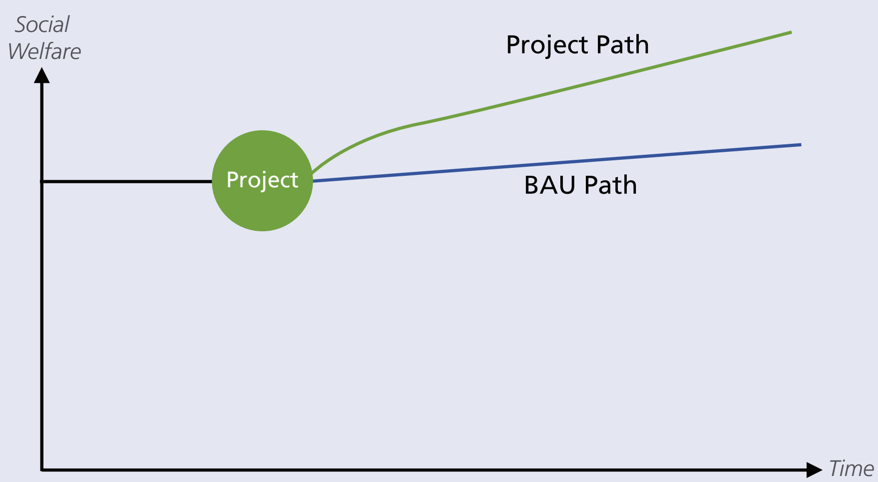
3 Consumer surplus is the difference between what individuals are willing to pay and the price they have to pay for each unit of goods or services consumed. It is a theoretical proxy for welfare.

Figure 2.2.
The Path of Social Welfare over Time



Source: Authors' representation.

Figure 2.3.
Dynamic Welfare Paths for Project and BAU Cases



Source: Authors' representation.

Inclusive Wealth and the Resilience Dividend

Estimating the resilience dividend requires information about how well-being changes in two states of the world: one with the resilience project and one with the BAU case. Figure 2.3 provides an example for how the welfare paths for a project and the BAU scenario may diverge once a project is implemented. The area between these two curves provides a measure of the resilience dividend.[4]

4 Here, we have considered a deterministic path to illustrate the idea of a resilience dividend. In the next section, we expand these ideas to consider stochastic shocks, as the focus of resilience is on the ability to absorb as well as recover from shocks.

How the Resilience Dividend Valuation Model Compares to Project Evaluation

Formal project evaluation is the system of collecting and analyzing information about the inputs and outputs (short-term), outcomes (intermediate-term), and impacts (long-term) of projects to inform decisions about future actions.[5] Impact evaluations use formal statistical analysis and focus on causal linkages between the project and outputs, outcomes, and impacts. Project evaluations are ex post in nature in that they look back on a project that is completed.

Using RDVM to evaluate projects ex post has much in common with project evaluation, albeit in a more formal, systems dynamic framework. Most formal evaluations use some sort of a logic model to link activities of the project (the inputs) with outputs and outcomes (see Figure 2.1). RDVM does this in a formal way by specifying the capital stocks, production relationships and allocation mechanism, and goods and services of the system, and focusing on the causal relationships between project activities and changes in these system elements. It compares changes in the flow of goods and services between (potentially) observable outcomes from the project and an appropriately constructed counterfactual. In both cases, the assumptions within each type of model form the linkages of framework components.

There are, however, some unique aspects to the RDVM compared to project evaluation. First, RDVM is specifically based in economic theory, in that we conceptualize the goods and services to be arguments in the social welfare function(s) of stakeholders. That is, we view stakeholders as economic agents that derive well-being from the production or consumption of the goods and services produced by the capital stocks. This provides the foundation for valuing the resilience dividend in a manner similar to traditional benefit-cost analysis, and for aggregating it across disparate goods and services. Importantly, the focus is not necessarily on goods and services traded in markets but on the non-market goods and services that are provided by the system.

Second, resilience practitioners are typically concerned with certain aspects of the concept of resilience, including but not limited to absorptive and adaptive capacities and the co-benefits that are generated from resilience projects. While it is not always possible to separate the resilience dividend into these concepts, the RDVM's dynamic structure does provide some guidance to estimating and categorizing these benefits.

Third, the RDVM allows estimating the value of the components of a project. When projects have multiple mechanisms that affect the system, each part's value may be important in and of itself regardless of the value of the larger project (or portfolio of projects). Importantly, the framework also allows the analysis of interdependencies that might affect the value of related project components. The value of the two projects together may be less than the sum of the value of the individual projects; in this case the projects may be viewed as substitutes. Conversely, when the total value is greater than the sum individual values, these projects may be viewed as complements.

5 USAID. Local Systems: A Framework for Supporting Sustained Development. Washington, D.C., April, 2014.

SECTION 3

Elements of the Resilience Dividend Valuation Model and Case Archetypes

This section describes in more detail the elements of the RDVM. It provides a few examples and guides practitioners in how to map out a given system using the conceptual framework for estimating the resilience dividend.

Capital Stocks

Capital stocks are a system's "capital assets … broadly defined to include natural, human, and social forms of capital in addition to reproducible capital," such as machines.[1] They are durable quantities that, when combined with particular technologies, contribute to flows of goods and services over time. Because capital stocks are assumed to be durable, they have the potential to evolve over time through both natural and man-made processes. Capital can have positive values (assets like human and man-made capital) or negative ones (stocks such as pollution).

Practitioners who want to apply the RDVM will need to identify the capital stocks that characterize the system of interest, and understand how they a) might evolve; and b) contribute to the production of goods and services. Given capital stocks' role as inputs into production, collecting data about them both before and after the project can be valuable as indicators of a resilience dividend, especially when a particular good or service is difficult to measure or information on values are missing. In other words, if it can be shown that a productive capital stock has increased in quality or quantity as a result of a resilience project (coupled with an assumption about productive relationships), then there is evidence of a resilience dividend.

Goods and Services

Goods and services are flows produced by combining capital stocks through a production relationship and valued by stakeholders. In the resilience context, this can include such diverse items as market and non-market goods and services, or protection and mitigation services provided through private or public infrastructure or actions.

1 Irwin, E. G., et al. (2016). **8**: 81.

Goods and services provide the "physical" measure of the items that are valued in the system. In economic terms, value refers to the willingness and ability of a stakeholder to pay for an extra unit of the good or service, or the willingness to accept a payment as compensation for enduring something "bad." If stakeholders' satisfaction increases with the production or consumption of a good or service, then this good or service is valuable.[2] An individual would be willing to trade something else of lesser value (such as income) in order to obtain it and still be made better off.

Practitioners interested in applying the RDVM will need to identify the goods and services that are expected to change, either directly or indirectly, as a result of a resilience project relative to the BAU baseline. Valuing these changes is the basis for calculating the quantitative resilience dividend. In some cases, the value of the change can be directly observed or easily estimated (e.g., change in agricultural output as a result of a development project). In other cases (e.g., changes in benefits from ecosystem services such as flood protection or recreation), the physical and monetary values may come from different sources. Practitioners should identify the most comprehensive set of potentially changed goods and services as possible—both measurable and non-measurable items—but ensure that each good and service fits into the conceptualization of the system. Changes in goods and services that cannot be valued quantitatively can be discussed qualitatively.

Some of these goods and services may only become apparent in certain contexts. For example, the value of a levee may only be realized once it has prevented damage from a storm. Thus, practitioners need to be cognizant of external forces' impact on the system and how these forces interact with capital stocks to produce other goods and services.

2 In economic terms, satisfaction is typically referred to as "utility."

Production Functions and the Allocation Mechanisms

Production Functions

Each good or service represented in the system is produced by combining the capital stocks with other goods and services. A *production function* describes these relationships. For example, the production of crops involves the capital stocks of land (a natural capital stock), water (another natural capital stock), labor (human capital stocks), man-made capital (tools), and fertilizer (a market good). In a disaster risk reduction framework, stocks of protective capital such as levees "gray infrastructure" produce valuable storm protection services, while "green infrastructure" involving natural capital can produce not only protection services but also co-benefits in the form of additional ecosystem services like recreation.

The logic of the RDVM suggests that practitioners should, at the very least, have a sense of which capital stocks combine to produce which goods and services, and anticipate if a resilience project has the potential to change these relationships relative to BAU. For example, a project that introduces new crop choices to agricultural producers essentially changes the production technologies used to generate valuable crops if these practices are adopted. A project that introduces new protective infrastructure for storms is a public good (affecting all newly protected stakeholders) that changes the flow of storm protective services.

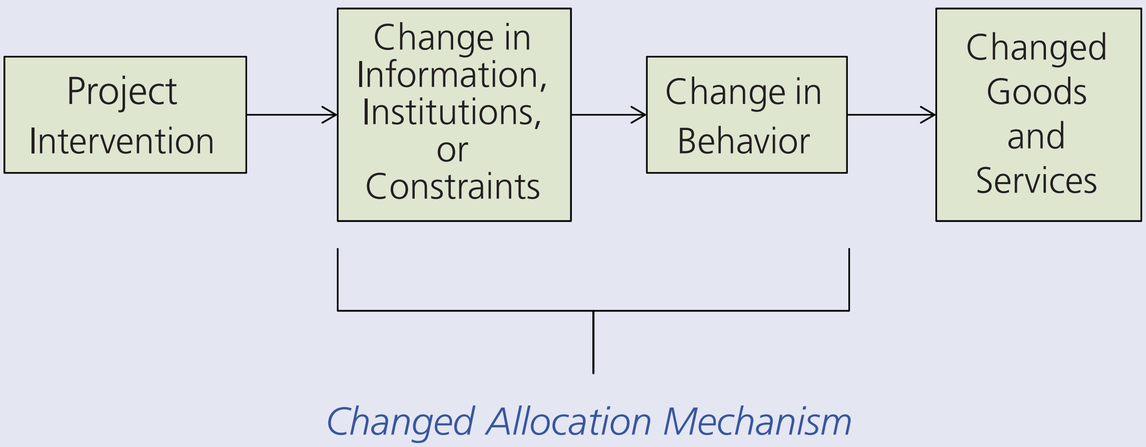
Allocation Mechanisms

The allocation mechanisms in the model represent the formal and informal institutional structures and behaviors that "determine[s] the current and future allocation" of the capital stocks and goods and services flows.[3] This includes both private and public goods and services, and the prices or constraints that economic agents face. Figure 3.1 provides an illustration.

3 Irwin, E. G., et al. (2016). **8**: 84.

Figure 3.1.

Changes in Outcomes due to Changes in the Allocation Mechanism



Source: Authors' analysis.

Although this concept is very broad, we offer two examples. First, consider the case of a market economy in a developing country with a set of private property rights (along with the rest of the institutions, norms, mores, and other components that support that system) and households that produce agricultural goods. The capital stocks are those listed in the footnote below,[4] and, for simplicity, let's say the households only produce one crop. Assume that due to a lack of fertilizer, the households face the stressor of declining land fertility. The allocation mechanism describes how the households will respond to this change in the quality of the capital stock of land. For example, at some point in the process, a given household may switch crops or abandon the land altogether, clearly influencing the flow of agricultural income. This expected behavioral change is represented in the framework by the allocation mechanism, which maps the decline in fertility to changes in production and, ultimately, income. The allocation mechanism can be thought of as the behavioral response to different levels of all the capital stocks.

If an intervention introduces new cropping options or improves access to fertilizer, the project essentially relaxes a constraint on the behavior of the household (or, equivalently, lowers the price of accessing those technologies). This change may ultimately impact behavior of at least a subset of households, which again would be reflected in the production of goods and services (crops) and, ultimately, agricultural income. In a backward-looking ex post case, changes in the allocation mechanism manifest themselves empirically in changes

4 That is, the capital stocks of land (a natural capital stock), water (another natural capital stock), labor (human capital stocks), man-made capital (tools), and fertilizer (a market good).

in behavior and/or the provision of goods and services in the framework; in a forward-looking ex ante case, such behaviors and provisioning would have to be assumed.

A second example is a change in government provision of public goods, such as building a storm protection system. In this case, the allocation mechanism describes how the new capital impacts the provision of storm protection services, likely through the change in (expected) damage to life (human capital) and property (other types of capital). Because this is an example of a public good, individual agents cannot opt out as in the first example, so everyone in the system is affected. But providing storm protection services may change the value of the protected land, which may change where production of other goods occurs (for example, if agricultural land that no longer floods is sold to a housing developer). The behavioral component is linked to the dynamic and spatial relationships of other capital stocks.

However, this link to capital is not always the case. One example might be a government developing disaster resilience plans and training that enable particular public and private behaviors (such as public agencies operating disaster relief sites or private individuals participating in search-and-rescue operations). The benefits of the planning and training exercises (greater protection services that reduce damage and loss of life) primarily occur during and immediately after a disaster, but they rely in part on the behavior of the agencies and individuals involved. Such changes, relative to BAU, would have to be estimated or simulated to quantify the resilience dividend associated with these activities.

Social Welfare Function

The social welfare function reflects the full social value of each good and service represented in the system. This can theoretically be done by calculating the full producer and consumer surpluses associated with a good or service flow at each point in time (including all use and non-use values of both market and non-market goods and services), and adding them together.

In practice, full social values (either total or marginal) are rarely available.[5] Prices can serve as a proxy for marginal values in some cases, and a large amount of literature exists for valuing any number of non-market goods and services.[6] Whatever values are used to represent the opportunity costs of the goods and services, practitioners should be explicit about the values used and endeavor to follow best practices in monetizing flows, as in benefit-cost analysis.[7]

Shocks and Stressors

Benefits from resilience projects are related to the ability of people to better withstand and recover from disruptions, to improve current situations, and/or to positively change the trajectory of a place and/or people's lives. Thus, the treatment of disruption in RDVM is important.

From a modeling standpoint, we distinguish the ex ante and ex post cases as follows:

- *Ex Ante*: The project case and the base case are evaluated using the probability distributions of the assumed set of potential shocks and stressors. This will require some assumption about the risk preferences of societies (or perhaps subgroups) in order to arrive at a single resilience dividend number. If probability information on the shocks and stressors is unavailable, a useful alternative would be to estimate the resilience dividend under a set of futures independent of probability distributions (i.e., construct scenarios on the basis of the uncertain variables and parameters of the problem) and keep the results scenario-specific.

5 In particular, consumer and producer surplus measures require information about the marginal social benefit and cost curves over the entire span of the quantity change.

6 See Champ et al. (2003) for a broad overview of methods for non-market valuation.

7 Farrow, S. and R. O. Zerbe (2013). *Principles and Standards for benefit-cost analysis*, Edward Elgar Publishing.

- *Ex Post*: The project is evaluated conditional on a particular shock or stressor path, rather than across an entire set of potential shocks or stressors. The (quasi-monetized) resilience dividend is the difference in wealth between the project and non-project paths starting from the time of the shock (or an assumed point along the stressor path). Note that it is possible to evaluate a project using the inclusive wealth theory even if a shock has not happened in the real world, since we can simulate such an event within the estimation. Validation of the outputs, however, would require empirical data.

Project Interventions

Resilience project interventions can change any elements of the system that ultimately affect the production or provision of valuable goods and services in the model, including:

- Quality or quantities of capital stocks;
- The evolution of the capital stocks;
- The production functions;
- The allocation mechanism(s); and
- The probability distributions of the stocks and stressors (or the feasible scenarios).

Changes in any of these elements relative to the baseline case will ultimately result in a change in welfare for at least a subset of stakeholders. The change in welfare can be positive or negative, and may be different for various subsets of stakeholders. When aggregated over all stakeholders, a positive change in the net present value of the difference in welfare paths is evidence of a positive resilience dividend.

Example Settings for Applying the Resilience Dividend Valuation Model

In this section, we discuss some of the primary case archetypes that practitioners might encounter. These examples are not organized by system or project type, but rather by the nature of the shock/stressor and the existence or non-existence of "co-benefits" that accrue as a result of a project even without a shock. These examples are notional, and additional configurations are possible.

We look at the following examples:

- Backward-looking ex post evaluations, in which the objective is to estimate (a portion of) the resilience dividend after a resilience project is implemented;[8]
- Cases with and without a co-benefit from a single observed shock;
- A case based on a stressor; and
- A forward-looking ex ante case.

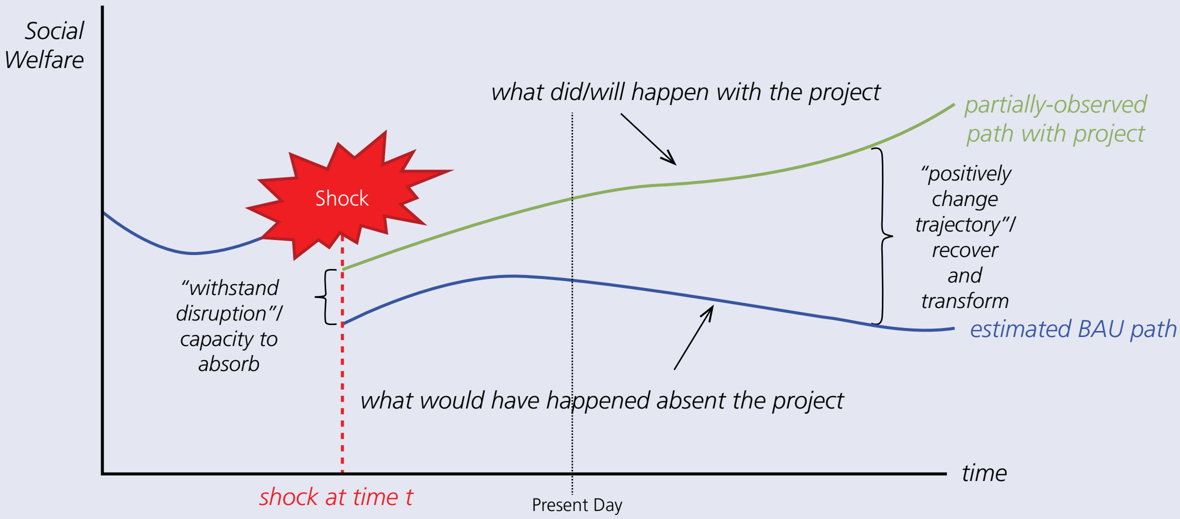
Ex Post Evaluation of a Project with No Co-Benefits and a Single Shock

In this subsection, we document the "simple" case of an ex post evaluation of a resilience project that is assumed to have no co-benefits (in that the welfare of the system after project implementation and before a shock is identical for both the project case and the BAU case). Figure 3.2 presents an illustration of the case.

8 We say "a portion of" as there are potential benefits that accrue after the shock due to the project, and we are only considering the benefits that have occurred up to the present time and not projecting into the future.

Figure 3.2.

Valuing a Project with No Co-Benefits and a Single Shock



Source: Authors' representation.

The vertical axis of the figure represents social welfare, and the horizontal axis is time. Note that because this is for an ex post evaluation, present day falls to the right of both the project implementation (not shown) and the observed shock. Prior to the shock, the welfare paths of the resilience project scenario and the BAU scenario are identical.

After the shock at time *t*, however, the (partially observable) path with the project (represented in green) and the (unobservable) path without the project (the BAU case, represented in purple) diverge. Around the time of the shock, this divergence can be conceptualized as the value of the project in terms of increasing the capacity to withstand disruption or, equivalently, to absorb the shock. The vertical distance between the two paths, measured in units of social welfare, thus provides one component of the resilience dividend.

However, given potential differences in the quality or quantity of capital stocks, their state transitions, and/or changes in the allocation mechanism following the project and shock, the two paths may continue to diverge after the shock. As long as the only difference between them at future points in time is the presence or absence of the resilience project, this differential at each point in time is also a component of the resilience dividend. We note, however, that we are likely to only have partial empirical evidence about the full dividend, as we are unable to observe even the project path at points in the future. This is particularly problematic in empirically estimating a project's transformative capacity, as even if one was sufficiently distant from the shock and had sufficient data to estimate the BAU path, the ability to control for all other effects acting on the system would likely be limited.

What we might term the *estimable ex post resilience divided* is thus the net present value of the difference in welfare paths between the project and BAU from time *t* to the present day. Any projection of the dividend beyond the present day would necessarily require ex ante methods.

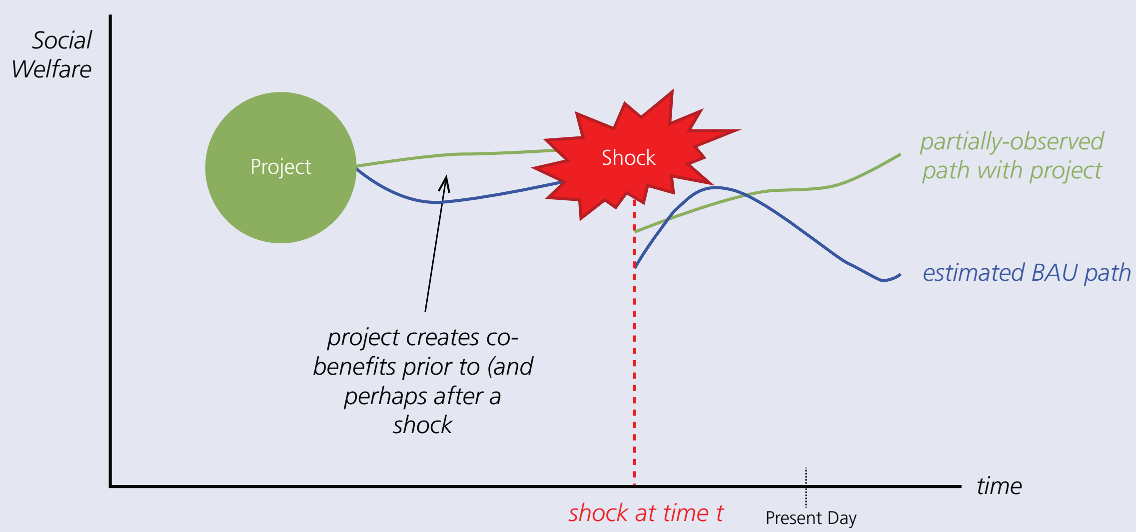
The key empirical components in estimating the resilience dividend in this case are:

- Estimation of the BAU path; and
- The economic valuation of the flows of goods and services that contribute to the divergence.

Ex Post Evaluation of a Project with Co-Benefits and a Single Shock

This case retains the ex post approach but illustrates a case where benefits to society do not depend on a shock occurring. In other words, the project generates additional benefits (termed co-benefits) that accrue even in the absence of a shock, relative to the BAU case. Returning to our example of a green versus gray infrastructure project for storm protection, green infrastructure might result in additional recreational and environmental benefits over the BAU case, even if storm protection is identical. Figure 3.3 provides an illustration of this general case, allowing for the possibility that the resilience case provides greater levels of absorptive capacity than the BAU case.

Figure 3.3.
Valuing a Project with Co-Benefits and a Single Shock



Source: Authors' representation.

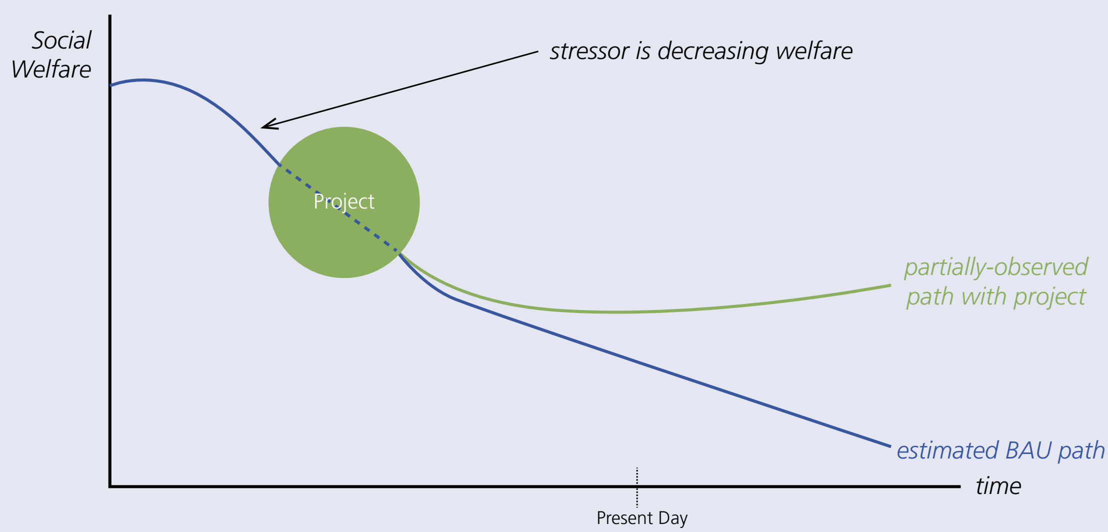
The primary difference from the previous archetype illustrated in Figure 3.2 is the divergence in welfare paths after project implementation and before the shock. Like the previous case, however, the resilience dividend is calculated as the net present value of the difference in welfare over some time period; in this case, the ex post calculation could be done from the time just after project implementation to the present day.

Ex Post Evaluation of a Project with a Stressor

This ex post approach illustrates a case where the system is under the influence of a stressor, rather than a shock. Consider the example of an excessive depletion of groundwater due to open access. In this case, the stressor is the downward trajectory of a stock of natural capital due to sub-optimal extraction patterns. Figure 3.4 provides an illustration of this general case.

Conceptually, the key difference between this and the previous shock examples is that the stressor is ever-present instead of a discrete event. As such, we tend to think of the project and BAU paths as relatively continuous over time, rather than exhibiting a discrete jump at the time of the shock. In other words, absorptive and adaptive capacities are implicitly given by the slopes of the welfare paths, rather than in the differences in welfare immediately following a shock.

Figure 3.4.
Valuing a Project with a Stressor



Source: Authors' representation.

Ex Ante Evaluation of Projects

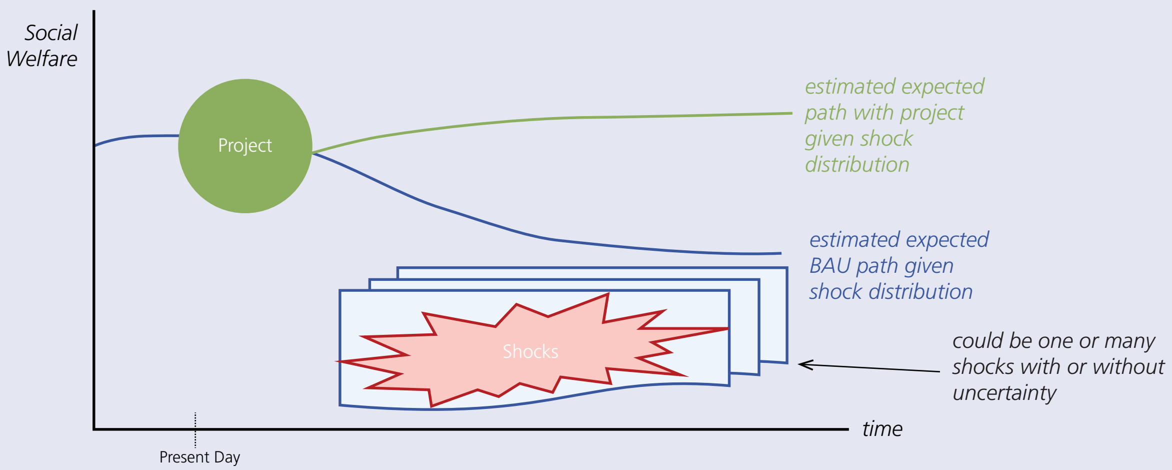
This case conceptualizes the resilience dividend using an ex ante, rather than an ex post, approach. There is no information about the performance of the project because either the implementation is not complete or ex post data does not exist. Figure 3.5 provides an illustration.

In this case, the lack of data suggests a different empirical approach to calculating the resilience dividend. Unlike ex post cases in which statistical models can be used to infer relationships between system elements, this option is not available ex ante. Rather, the relationships between system elements come from previously observed or estimated relationships from other systems or assumed. Of course, if the latter is used, sensitivity analysis should be used to test the robustness of the calculated dividend to the assumptions.

Furthermore, in ex ante cases, the model is no longer necessarily deterministic, but involves stochastic elements related to potential shocks.[9] This allows modeling of multiple shocks or stressors using the probability distributions associated with them, and calculating the resilience dividend as a random variable. Figure 3.5 provides an example using expectations over the random elements, in which the expected (partial) resilience dividend could be estimated.

9 Note that in the ex post cases, we conditioned on an observable shock, set of shocks, or stressor(s). This is not possible for ex ante cases. However, one could, in theory, use degenerate probability distributions for individual shocks (i.e., the probability of the event occurring in the future is one) to model particular scenarios.

Figure 3.5.
Valuing a Project Ex Ante Using Expectations



Source: Authors' representation.

SECTION 4

Using the Resilience Dividend Valuation Model and Data to Assess the Resilience Dividend

This section describes the steps for using the RDVM framework to estimate the resilience dividend. Practitioners should be aware that this is not a "toolkit" in which pre-defined tools can be extracted and applied to a given intervention. Rather, the steps described below detail the approach to calculating at least part of the resilience dividend for purposes of decision support while remaining flexible.

General Steps in Applying the Resilience Dividend Valuation Model Framework

There are six major steps to estimating the resilience dividend using the RDVM:

1. Define the intervention and BAU scenarios
2. Map the system
3. Define the shocks and/or stressors
4. Map out the changes to the system in the intervention and BAU scenarios
5. Estimate the intervention and BAU paths
6. Aggregate the estimates of well-being.

How these six steps are implemented will depend on the type of system, type of intervention, and type of evaluation (post-project or pre-project). The six steps apply to both pre- and post-project analysis, but the way they get carried out and the relevant analytical methods will differ. The biggest difference in terms of steps is Step 5; estimating the project and BAU paths will be very different depending on whether the project has been implemented.

The approach is meant to be a guide for how to estimate the resilience dividend, not a calculator. This makes the model more flexible but not as straightforward to use as some other tools. Our goal is to balance the need for a broad, flexible approach with clear guidance on how to implement the model.

Ex Post Cases: Valuing the Dividend after a Project is Complete

General Principles

As with all project evaluations, estimating the resilience dividend for a project will be most successful when done as part of the project planning process. In particular, baseline data is vitally important to understanding the state of the system prior to the intervention, and collecting baseline data after the fact is challenging, costly, and unlikely to lead to high-quality measurement. We have emphasized the importance of causality in estimating the resilience dividend, and incorporating the dividend in the planning process may make it easier to carry out the project in a way that supports causal analysis.

Practitioners should strive to quantify the resilience dividend to the greatest extent possible, which means collecting quantitative data wherever feasible. Not all impacts or relationships within the system may be able to be quantified, and qualitative analysis may be used to supplement the quantitative aspects.

Recall that resilience is a dynamic concept. There may be immediate benefits once a project is implemented, while other benefits may only be realized after a shock occurs. This means that data collection efforts may need to be dynamic as well. Additionally, changes in transformative and adaptive capacity may not be revealed until sufficient time has passed. For example, an intervention to increase storm protection capital may have immediate benefits through the absorptive capacity but may fundamentally transform land use, which may take time to occur and observe. Understanding when and how the potential benefits arise is fundamental to forming a data collection plan.

Additionally, the data collection plan should be developed in conjunction with the system mapping. This allows the practitioner to understand how goods and services are likely to be affected by the project. The goal is to understand how the pieces of the system fit together and impact each other. With this mapping, it is more likely that the right data will get collected.

Using the Resilience Dividend Valuation Model for Ex Post Cases

While we present this guide as a linear process, the reality is that developing the conceptualization of the system is likely iterative, with one consideration later in the list potentially affecting one or more of the elements that appear prior to it. Our hope is to provide guidance for what needs to be considered, but there is no formulary for estimating the resilience dividend in all contexts. The RDVM provides a way to conceptualize the system and consider what data collection and modeling are needed in order to estimate the impact of a project on a complex, adaptive, dynamical system. As we move to more complicated projects and portfolios of projects, systematically thinking about how the system and its interdependencies change is vitally important to estimating the resilience dividend.

1. **Define the resilience project and the BAU case**

   – *Define the project activities associated with the project.*
   Using project documents and other materials, define the activities associated with the resilience project, paying particular attention to whether project activities are expected to directly affect the quality and quantity of capital stocks, any production technologies, or the allocation mechanism through changes in institutions, norms, or social relationships.

   –- *Define the counterfactual BAU case.*
   For counterfactuals that use a non-resilience project as the BAU case, define the associated activities, as you did with the project activities.

2. **Map the system**

   – *Identify the relevant capital stocks for the system being modeled.*
   Define the man-made, natural, human, and social capital stocks that are used by stakeholders within the system. Ideally, all capital stocks that are expected to evolve or change should be included in the model.

– *Identify the relevant goods and services for the system being modeled.*
All goods and services that are assumed to impact the welfare of stakeholders, whether they are marketed or not, should ideally be included. These are called "final" goods and services. Additional "intermediate" goods and services that are used to create these final goods should be included if they will likely change with the project.

– *Identify the stakeholders whose welfare will be affected by the project intervention.*
All stakeholder groups that are affected by the resilience project should be identified when mapping the system. Individual practitioners will have to decide how to aggregate stakeholders into different groups. In some cases, a single group may be appropriate; in others, especially where distributional issues are important, more than one stakeholder group may be appropriate.

– *Document the marginal or average values associated with the goods and services.*
Each good and service in the system will need to be valued in some way in order to monetize the resilience dividend. For marketed goods and services, market prices will often provide a good approximation of the value of the incremental unit. For non-market goods and services, alternative methods (e.g., stated preference analysis or benefit transfer) may be required.

– *Map the posited relationships between capital stocks, goods and services, and well-being of stakeholders.*
This is perhaps the most critical step in the mapping process, as it provides the practitioner's logic model about the key relationships within the system (see Figures 2.2 and 2.3). Each good and service represented in the system should map to either the social welfare of a stakeholder (or stakeholder group), or be used as an intermediate input into other production relationships. Similarly, the production of the goods and services depends on intermediate inputs and capital stocks, and these relationships should be clear.

3. **Define the shocks and/or stressors**

   Conceptualize how the observed shock(s) (if applicable) and stressor(s) (if applicable) are expected to change the quantities or qualities of capital stocks and the production relationships and/or the allocation mechanism(s).
   In this step, the stocks and stressors threatening the system are defined in terms of the disruptions that might occur under should these events occur at particular magnitudes. In other words, this step provides the theoretical logical relationships between the shocks/stressors and elements of the system.

4. **Conceptualize how the BAU case and intervention change the relationships in the system**

   For evaluations that use a BAU project that is different than the current state of the system, this step maps out the relevant relationships for that project. In ex post cases, it seems likely that only in rare circumstances would a practitioner have empirical evidence for both a resilience project and BAU case. In such circumstances, it seems likely that either ex ante approaches or mixed methods may be most useful.

   Resilience project interventions can change any elements of the system that ultimately affect the production or provision of valuable goods and services in the model, including:

   - Quality or quantities of capital stocks;
   - The evolution of the capital stocks;
   - The production functions;

- The allocation mechanism(s); and
- The probability distributions of the stocks and stressors (or the feasible scenarios).

That said, using the inclusive wealth theory to represent dynamic systems suggests that practitioners may want to consider the types of changes listed below when developing a model to estimate the resilience dividend. These categories should not be considered distinct and non-overlapping, nor are they necessarily comprehensive, but project activities should be mapped to these types of changes. For additional examples organized in a slightly different manner, interested readers are referred to benefits and indicators contained in Tanner, et al., da Silva and Morera and Cutter.[1]

Changes in the direct provision of public or quasi-public goods. In economics, public goods are described as being non-rival in consumption (meaning that consuming the good does not affect its availability for others) and non-excludable (meaning that they are accessible to everyone due to a lack of property rights). Quasi-public goods (e.g., toll roads) have elements of non-excludability or non-rivalry, but they are not pure public goods. Public and quasi-public goods can be provided by both private individuals/firms, and organizations, or governments.

Because of their properties, the proper valuation of a change in the provision of a public good is to sum the benefits that accrue to every stakeholder affected. Many public goods are not traded in a market-making valuation complex. However, as mentioned earlier, economists have developed several methods to value non-market goods and services based on both stated and revealed preferences.

Major categories of public good provisions that might be affected by resilience projects include, but are not limited to:

- Storm and environmental protection services;
- Other environmental goods and ecosystem services;
- “Social” goods and services directly provided by governments or other formal institutions (e.g., welfare systems and other transfer payments); and
- Publicly available information (e.g., early warning systems, information about alternative crop choices, etc.)

We note that some of these categories can directly change welfare via changing the production or allocation of public goods or resources, while others (such as the provision of information) enable a change in behavior that can subsequently be used to alter the production or consumption of private goods.

Changes in the quantity or quality of man-made, natural, or human capital stocks. Changes that augment quantities or qualities of capital stocks, or alter their evolution over time, will affect the provision of the goods and services that these stocks support.[2] Both public and private decisions can change these system elements. There may be considerable overlap with the direct provision of public goods listed above. For example, a city government constructing infrastructure for storm protection adds an asset to the stock of man-made capital, which in turn improves the flow of storm protection services; additionally, households could modify their house to avoid damage. Indirect changes to capital stocks can alter their evolution. For example, in the case of a natural resource, a change that results in greater consumption of the resource will decrease the quantities available relative to the BAU case. Similarly, an intervention may slow or reverse

1 Arup International Development (2014). City Resilience Index: Understanding and measuring city resilience, The Rockefeller Foundation, Arup International Development.

Tanner, T. M., et al. (2015). The Triple Dividend of Resilience: Realising development goals through the multiple benefits of disaster risk management. London, Global Facility for Disaster Reduction and Recovery (GFDRR) at the World Bank and Overseas Development Institute (ODI).

Cutter, Susan S. (2016). The Landscape of Disaster Resilience Indicators in the USA, *Natural Hazards* 80:741-758.

2 This includes both public and private goods and services.

depreciation of a stock (such as increased maintenance of an aging power plant) or augment its quality (such as an investment in education improving the productivity of human capital).

Changes in formal or informal institutions. The institutional structure of a particular system, either formal or informal, is conceptualized as the set of "rules" under which economic actors can behave. This includes any and all constraints on behavior, the incentives that people and firms face, and other aspects that shape behavioral outcomes. Changes in institutions indirectly change the flow of goods and services through changes in behavior, reinforcing the importance of modeling behavior with RDVM via the allocation mechanism.

The following categories seem particularly important in the resilience context:

Changes in incentives. This includes changes in relative prices in a market economy, as well as changes in any other reward or punishment system that ultimately affects behavior. This can include regulatory structures, taxes and subsidies, and other government policies.

Changes in access to capital stocks or goods and services. Although this can be viewed as a change in incentives, any changes in access can have behavioral implications. For example, if social norms or other transaction costs precluded a particular group of people from engaging in a production activity or accessing a resource, overcoming those costs might change the behavior of some individuals within this group, allowing for augmented production/consumption of certain goods and services.

Changes to privately available information. Some resilience projects may provide information that is not necessarily public, but because it is new or packaged in a new way making it more accessible to a wider audience, it may affect the behavior of particular individuals included in the project intervention going forward.

Changes in access to technology. Access to methods, techniques, skills, and processes used to create goods and services can change the manner in which capital stocks are combined to create flows of goods and services. This change may arise from a change in the incentive structure of the system, as discussed above, or the introduction of new technologies may be a direct intervention as an activity of the resilience of the project.

Changes in social capital. Social capital has been defined at various levels, in particular as the "trust, norms and networks that can improve the efficiency of society by facilitating coordinated actions" and also as "the institutions, relationships and norms that shape (up) the quality and quantity of a society's social interaction".[3] It exists as a form of capital that is productive since it helps achieve certain outcomes once it is put to use.

Given this definition, we see that there is considerable overlap between changes in this category and "changes in formal or informal institutions" discussed above. Practically speaking, however, by changing transaction costs and network structures, changes in social capital can facilitate alternative behaviors, thus changing the flow of goods and services along a project path.

5. **Relate and estimate the project and BAU paths**

Ultimately, the value of any project activity is derived from the changed value of the affected goods and services. As such, an explicit link between changes in system elements and changes in goods and services produced or consumed should be defined. In cases of direct provision of goods and services, this is trivial. In other cases (such as changes in social capital, institutional structure, or system norms), a specific logic sub-model representing the allocation mechanism may have to be derived.

3 Agampodi, T. C., et al. (2015). "Measurement of social capital in relation to health in low and middle income countries (LMIC): A systematic review." *Social Science & Medicine* **128**: 95-104.

Using the available data, estimate the flow of goods and services at each possible point in time after project implementation, and before an observable shock. The following provides some guidance about the types of resilience benefits that may be estimated.

– *Estimate project and BAU paths prior to shock occurring to obtain short-run co-benefit estimates.*

  Co-benefits are generally defined as the value of the changes of the flows of goods and services that result from a project but are not directly related to a shock or stressor (see below). Any goods or services affected by a resilience project could theoretically be included in co-benefits. Given the diversity of resilience projects and systems, a precise taxonomy of potential co-benefits has the potential to be both limiting and misleading. We instead suggest that practitioners use their own judgment and the types of changes described above to consider their project's potential co-benefits.

  Practitioners should use causal inference methods to document the relationship between the flows of goods and services with and without the project.

– *Estimate project and BAU path during each observed shock to obtain absorptive capacity benefits.*

  Absorptive capacity benefits are generally defined as the benefits that accrue to a system during or immediately after a shock. In general, these benefits would take the form of fewer losses of valued goods and services. Practitioners should use causal inference methods to document the causal relationship between the project and changes in damages as a result of the project during or immediately after a shock.

– *Estimate recovery paths between each observed shock to obtain recovery/transformative benefits.*

  For projects that have enhanced recovery as an objective or sub-objective, the speed of system recovery is an important element of the resilience dividend. Practitioners should try to estimate the differences in flows of goods and services at each point in time for which data is available to get a sense of the time path of system recovery (or of the transformative benefits, in the case of systems whose welfare levels exceed what they were before the project). Again, causal inference methods are appropriate.

6. Aggregate welfare estimates

– *Calculate welfare at each available point in time.*

  Apply the marginal/average values to each good and service to convert into monetary terms for each estimation step above. Using the values obtained in the previous steps, the monetary value of changes in flows of goods and services calculated in the previous section can be obtained. Ideally, these will be indicators of true welfare of the stakeholders of the system such as consumer surplus and producer profits.

- *Convert the monetary terms for each segment of the time path into common units using discounting.*

  If changes in goods and services are calculated over time, and it is desirable to convert these flows of benefits and costs into a single, comparable figure, then the net present value of net benefits should be calculated.

- *Sum in order to calculate the resilience dividend.*

  All monetary benefits and costs can be summed to obtain the resilience dividend.

Ex Ante Cases: Valuing the Dividend and Choosing Between Projects

General Principles

The general approach to estimating the resilience dividend in ex ante cases is similar to the approach for an ex post case. The biggest difference is that in the ex post cases, changes in the system and outcomes may be observed, but in the ex ante case, predicted outcomes are dependent upon lessons from similar projects in other locations or results based on simulation models. Additionally, more than two paths may be of interest; when stakeholders are trying to choose among multiple projects with similar goals, each project path must be estimated.

As with the ex post cases, conceptualizing the system and how the intervention and BAU cases change the system provides a framework to follow. It is easier to return to the framework later and delete an aspect that was found to be unimportant than to try to retrofit the framework when alterative impacts or processes have been identified. To operationalize the conceptualization of the system, simulation models may be needed to quantify changes to the system. Systems-level models can quickly become unyielding when there are too many components. As such, the essential components need to be included, but some abstraction may be required so that the important aspects of the system are considered.

Using the Resilience Dividend Valuation Model for Ex Ante Cases

The steps for using the RDVM in ex ante cases are identical to those in the ex post cases, with the exception of estimating the impact of the project and BAU cases on the system. Specifically, rather than having observed project impacts after a project is completed and estimating the BAU baseline, as in ex post cases, we must estimate both paths. This will involve two key aspects, calibrating a model to the system being considered and estimating the dynamic paths of the intervention and BAU baseline. This calibrated model may be as extravagant as a coupled hydrologic-ecologic-economic model or taking the results from a similar intervention in another area and transferring those benefits to the intervention at issue. Many disaster risk reduction projects may already be doing this, for at least some part of the system. For example, estimating the reductions in damages from flood risk projects is standard operating procedure. What this model advocates is an expansion to understand how the dynamics of the system change as we expand the number of sectors/services that are provided. Comparing green and grey flood infrastructure is about considering the set of services provided by different capital stocks that these different interventions provide. Different interventions may affect the system in very different ways, and this approach allows for an analysis of very different interventions.

Choosing between Projects

The choice of a project depends not only on the benefits that it provides but also the costs that are imposed. The approach outlined here, in an ideal situation, will allow stakeholders to estimate the net present value of the net benefits of the project. These impacts can be disaggregated across stakeholder groups to better understand who wins and loses and at what magnitude in a wide range of potential interventions. Although the net present value of the net benefits may be larger for one project than another, the distribution of net benefits may be just as important to stakeholder decisionmaking. There are tradeoffs for each project, and even when these can be converted to a common metric, the choice between projects may be difficult. These tradeoffs may include not only differential benefits across stakeholder groups but also some benefits may only be specific qualitatively, complicating the choice of project. But explicitly knowing the dimensions of the tradeoff for different projects increases the ability of the stakeholders to make good investments from a resilience perspective.

SECTION 5

Key Considerations for Decisionmakers

The RDVM admittedly has significant real-world limitations, but we contend that the use of a conceptual model based on economic theory and based in a systems dynamic framework can provide benefits to the resilience practitioner community in terms of systemically thinking about resilience projects, and how to provide evidence of additional benefits that might come from resilience-based projects relative to the status quo. It is a complement to, rather than replacement of, other ways of thinking about the resilience concept. And while it provides a theoretically-consistent way of thinking about the resilience dividend, there may be considerable hurdles to overcome in order to use the model across a wide variety of circumstances.

Section 4 describes an ideal use of the inclusive wealth theory to estimate the resilience dividend, but it is primarily conceptual in nature. Although practitioners should strive to accomplish each step to the best of their ability with the resources available, real-world applications will likely need to be much simpler. For example, in an ex post case, data may only be available at two points: pre- and post-project implementation, with or without a given shock. Even then, relative to the conceptualization, data may not be available on all relevant measures. In an ex ante case, even with an appropriate simulation model that represents expected behavioral change, a full probabilistic representation of the expected shocks may be beyond the scope of a study, or at least its budget.

Below, we document some of the key skills that would need to be brought to bear in order to use the model to estimate a resilience dividend, and discuss the likely data limitations that might be found in the real world (informed largely by the case studies that we performed over the course of the research).[1] We also talk about information that could be used to provide evidence for a resilience dividend, even if information to monetize the dividend was unavailable.

Skills Needed to Apply the Resilience Dividend Valuation Model

The RDVM is a complex approach based in economic and systems theory and requires high-level skills. It combines aspects of program evaluation with economic valuation, including structural and empirical dynamic modeling, causal inference, and benefit-cost analysis. The approach itself is extremely data intensive, and because resilience projects often rely on enabling certain aspects of human behavior, relatively sophisticated modeling techniques may be necessary. In particular, the following skills would be helpful in calculating the resilience dividend using this method:

1 Bond, C., et al. (2017). *Resilience Dividend Valuation Model: Framework Development and Initial Case Studies*, Santa Monica: RAND Corporation. RR-2129-RF.

- Experience with formal program/project evaluation
- Experience with causal statistical inference
- Experience with simulation modeling
- Experience with benefit-cost analysis and other economic techniques
- Experience working with imperfect data

Model Relationships as Hypotheses

The map that arises from thinking about relationships between capital stocks, goods and services, behavior, and well-being (Figure 2.1) is essentially a hypothesis map, with each identified relationship representing a hypothesized linkage. For backward-looking ex post projects, data could theoretically be collected to test the linkages and quantify the difference in measurable system elements between the project and BAU scenarios. For forward-looking ex ante projects, the linkages are assumptions that would typically be represented by simulation models. Ultimately, the dynamic project and BAU paths (see, e.g., Figure 2.3) are aggregations of the value of changes provided by changes in the system elements.

Working with the Realities of Limited Data

The full theoretical resilience dividend requires calculating the net present value of the differences in net benefits (or costs) between the project intervention and BAU cases, quite possibly in a probabilistic framework that represents future shocks. However, the data requirements to calculate the theoretical ideal are likely too extreme for most projects.

Practitioners operating in an ex post environment will likely need to prioritize both the types of data collected and the points in time that the data is collected. The following lists some of the major elements that should be considered:

- Types of benefits that are most important/most salient to the project
- Timing of the data (when and for how long to collect)
- Treatment of distribution of future shocks
- Monetizing vs. not monetizing changes in the flow of goods and services
- Quantitative vs. qualitative data

Any evidence of a differential between the BAU path and project path due to the intervention is evidence of a potential resilience dividend.[2] Given restrictions on data availability, the estimable dividend may be a subset of the full dividend (e.g., only a subset of potentially valuable outcomes is monetized or evidence only exists at one or a small number of discrete points over time). In these cases, practitioners have the option of including additional assumptions in order to more completely characterize the resilience dividend (for example, assuming that the value of a set of co-benefits will persist at each point into the future), or perhaps more simply, reporting the empirical evidence that they have and recognizing that the estimate is not complete.

Recommendations Related to Data Collection

First, we recommend that the evaluation mechanism for a backward-looking project be developed in conjunction with the systems approach. The RDVM can be used to prioritize data collection efforts related to the capital stocks, goods and services, and behaviors that are likely to be affected by an intervention. Issues of quantification and measurement should be addressed at the early stages of the development of an empirical strategy, and care should be taken to identify the public and private goods and services, capital stocks, and behavioral changes that are anticipated as a result of the project.

2 Note that a negative change in welfare is interpreted as a net cost, or a negative resilience dividend.

Second, we recommend that practitioners prioritize the most salient aspects of the system they are analyzing and design any data collection mechanism accordingly and in conjunction with the project budget. There is a trade-off between the extent to which the resilience dividend can be characterized and the resources used to estimate it. As such, prioritization is in order. For example, in some cases, it may be desirable to focus attention broadly on various aspects of co-benefits as opposed to the temporal dimension of recovery, suggesting that cross-sectional data may be sufficient. In other cases, the temporal path of welfare may be paramount, in which case time series data may be necessary.

Finally, we urge practitioners to use the conceptual model as a hypothesis/assumption map that provides empirical guidance as to what data should be collected and what aspects of the dividend should be included in calculations. The idea is to avoid tautologies and provide a means of testing hypotheses about relationships within the system. If users cannot document the links between an intervention and valuable goods and service flows for at least some subset of stakeholders, then there is no falsifiable hypothesis to test. This should be avoided.

Glossary

Table G.1.

Mapping Language Used in the Resilience Community to the Inclusive Wealth Context

Resilience Community Language	Inclusive Wealth Language
Adapt	Changing the "economic program" of response to changes in particular capital stocks; may require a sub-framework to describe changes in response
Co-benefits	The additional benefits (costs) associated with a resilience project other than those relating to withstanding or recovery from shocks and stressors
Direct Benefits	The benefits provided by both a resilience project and related to withstanding or recovery from shocks and stressors
Entity	System being frameworked (collection of capital stocks, flows, and values)
Final Services	A service that is directly provided by one or more capital stocks and directly enters the social welfare function
Grow	Positive changes in inclusive wealth or overall welfare
Indirect Benefits	Synonym for co-benefits
Intermediate services	Linkages between capital stocks and flows of goods and services that do not directly enter the social welfare function
Inter-system	Linkages in capital stocks between quasi-separable subsystems
Intra-system	Linkages in capital stocks between a given (sub)system
Prepare for disruptions	Policy levers within the system that change: a) system dynamics; b) the "economic program", or how we assume the human system responds to changes in the capital stocks; c) the probability distributions described in the system; or d) the values embodied in the framework

Resilience Community Language	Inclusive Wealth Language
Resilience	The capacity of a system—a household, a community, an organization, or a coupled natural-human system—to prepare for disruptions from outside of the system, to recover from shocks and stresses, and to adapt and grow from a disruptive experience
Resilience Capacities – Absorptive	Reflected by either ex ante or ex post project performance evaluation, generally related to the ability to either reduce damage from a stock or slow/stop/reverse a stressor
Resilience Capacities – Adaptive	Reflected by either ex ante or ex post project performance evaluation, generally related to the ability of the human system to respond to changes in capital stocks
Resilience Capacities – Transformative	Reflected by either ex ante or ex post project performance evaluation, generally related to the overall dynamic path of the system
Resilience Dividend	The difference in the stream of net benefits to well-being between resilience projects and a counterfactual setting
Resilience Lens	A view of the world that approaches project development and investment strategies in a way that takes into account system properties and addresses both the risk of loss from a shock or stress outside the system and the resulting co-benefits the project produces
Resilience Project	An intervention that at least in part targets improved ability to manage, respond to, or recover from a shock or stress outside of a system that, with some probability, results in a loss of well-being and that has the potential to produce other benefits not directly related to the shock
Shocks	A discrete, probabilistic event exogenous to the system
Stresses	A long term trend in one or more capital stocks frameworked within the system (endogenous depreciation)

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