Context Document: Wastewater Treatment Plant Upgrades and Gray Water Reuse Ecosystem Service Logic Model

Project: GEMS
http://bit.ly/NI-GEMS

Ecosystem Service Logic Models (ESLMs) are conceptual models that summarize the effects of an intervention, such as a habitat restoration project, on the ecological and social systems. Each model links changes in biophysical systems caused by an intervention to measurable socioeconomic, human well-being, and ecological outcomes. ESLMs assume that the restoration is successful and include all potentially significant outcomes for the intervention; not all outcomes will be relevant to each individual project, depending on location and environmental conditions.

The direction of an outcome (whether the restoration will have a positive or negative influence) often depends on the specific situation or is unclear due to multiple links (arrows) leading into an outcome that may have opposite effects. Thus, language like “increased” or “decreased” is not included in the models. These models are often used to consider management with or without an intervention or to compare different interventions.

This context document includes additional information about the restoration approach and details about some of the relationships in the wastewater treatment plant upgrades and gray water reuse ESLM. It also includes a list of the references used to develop the ESLM and names of experts with whom we spoke to refine the model.

Wastewater Treatment and Gray Water Reuse Improvements in the Gulf of Mexico

Wastewater treatment plants (WWTPs) are offsite, centralized systems meant to remove toxins, pathogens, organic material, and more from sewage and wastewater coming from residential, industrial, and municipal environments. The most basic WWTPs include a primary and secondary treatment, and sometimes a tertiary treatment (Parsons 2016). The primary treatment consists of filtering solids and debris out so that all remains is a liquid portion of sewage (Parsons 2016). The secondary treatment typically uses microorganisms to absorb and eliminate biodegradable and organic components of sewage, such as food waste (Parsons 2016). Tertiary treatments are meant to eliminate micropollutants (MPs) which can include toxins and chemicals coming from sources such as fertilizers, pesticides, and pharmaceuticals (Parsons 2016). The WWTP upgrades referred to in this model are enhanced tertiary treatments to improve the quality of effluent discharged from wastewater treatment plants.

The remaining water after this treatment process is known as gray water and could potentially be used for services such as crop irrigation, industrial cooling processes, and in some cases drinking water (Grant et al. 2012). Gray water reuse can increase water productivity and reduce freshwater demand in the many places where freshwater is not an unlimited resource. Currently, in the Gulf of Mexico, there is residential wastewater treatment (decentralized and onsite) that allows for gray water reuse in homes and in rural areas as well as some pilot projects in Texas. In Alabama and Texas, legislation exists to enable and guide the implementation of graywater reuse (PPC Land Consultants 2017). To date, there does not appear to be wide-scale implementation of wastewater treatment plants harnessing and supplying municipalities with gray water for reuse (Grant et al. 2012). In 2015, Texas' Gulf Coast Waste Disposal Authority received a grant to evaluate the feasibility of building an industrial wastewater treatment plant that included a water reuse facility. This study found that the potential for water reuse is high (Parsons 2016). Future projects in the Gulf aimed at improving water quality and increasing use of gray water may be funded in similar ways.

External Factors That Influence Restoration Success

Population growth and development brings more wastewater to wastewater processing facilities which may not have the capacity to manage such increases (Vantarakis et al. 2016).

Model Notes and Clarifications

Social Cost of Greenhouse Gas Emissions: Certain retrofits to WWTP can reduce methane emissions that are typically generated from nonclaimed biosolids that settle out during the initial phases of wastewater treatment and enter the landfill. Methane from biosolids is captured and used for energy generation. Those biosolids are then reclaimed for fertilizer. (Stillwell et al. 2010), though this does not have an impact on the cost of fertilizer in the area of the project site and is therefore excluded from the model.

Potable & Nonpotable Water Availability: If a wastewater treatment plant were to integrate any mechanisms for gray water reuse after treatment, this would trigger a cascade of effects (including cost of fresh water) due to a change in availability of water, since the gray water would reduce the need for potable fresh water for certain uses, such as irrigation (Grant et al. 2012).

Cost of Wastewater Disposal: The reuse of wastewater also decreases how much effluent and wastewater is disposed of into aquatic and coastal systems, so has an added effect on the total industrial or municipal cost of wastewater disposal (Economic Development Research Group, Inc. 2011).

Groundwater Recharge and Saltwater Intrusion: Reclaimed water for wastewater treatment plants is often used for groundwater recharge (Sheng 2005). In coastal areas, freshwater pumped into groundwater moves seaward toward what is known as the zone of dispersion of transition zone where salt water and freshwater mix creating a brackish gradient. Because of this gradient, seawater is prevented from entering freshwater coastal aquifers. Seawater moving into freshwater aquifers is known as saltwater intrusion and can harm crops irrigated from that aquifer; it is an issue in coastal areas globally. Groundwater pumped into coastal areas can delay saltwater intrusion. Likewise, groundwater that is pumped away from aquifers that are connected to the sea may speed up the movement of seawater into freshwater aquifers because the zone of dispersion and gradient has more saltwater than freshwater (Barlow 2003).

Public Water Closures: Coastal and near-coastal water bodies in the Gulf of Mexico are occasionally closed for public uses, including swimming, recreational fishing, and commercial harvest, when poor water quality threatens public health. Pathogen and algal toxin concentrations exceeding regulatory standards are frequent reasons for these closures. While public water closures protect public health, they impact economic activity associated with the recreational uses and seafood harvest that are limited by the closures. This effect is represented in the ESLM through the links (arrows) from public water closures to the relevant human activity nodes (light blue boxes) and economic activity outcomes (yellow boxes). Public water closures may not be entirely effective at protecting the health of noncommercial (recreational and subsistence) harvesters, especially those who are not local to the area and may not be aware of closures (Reich et al. 2015).

Nutrition for Communities: This as an expected socioeconomic outcome of restoration projects can come from two sources: changes in fish and shellfish harvesting, and changes in land-based hunting on restoration areas. For this model, the source of nutrition is mainly from changes in fish and shellfish harvesting.

Property Values: In some areas, the link between wastewater treatment plant improvements and property values can be tenuous, as wastewater treatment plants do tend to be located in low-income areas where a multitude of factors impress upon the property value. However, one study showed that improvements of wastewater treatment that focused on odor and air quality may have impacts on property value (Bradley et al. 2002)

Experts Consulted

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