AN APPROACH TO EVALUATING CUMULATIVE IMPACTS IN GEORGIA'S WATERSHEDS USING BEST AVAILABLE DATA

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Abstract The State of Georgia is experiencing an unprecedented rate of growth which can contribute to an incremental conversion of land use within a watershed. To fulfill our requirements under Section 404 of the Clean Water Act (CWA), the US Army Corps of Engineers (USACE) is required to consider cumulative impacts to waters of the United States (US) when evaluating permit applications. An analysis of cumulative impacts, relative to past, present and reasonably foreseeable future impacts, is difficult given that best available information is often scarce and difficult to locate. However, the USACE, Savannah District has developed an approach that provides a reasonable assessment of existing resources within a watershed as well as estimates of future-anticipated impacts. While our current tools and existing data sets provide one method for evaluating cumulative impacts, it is important to note that our process is updated as new information becomes available.

INTRODUCTION

In many regions of the State of Georgia, the sprawl of low and high intensity development has been well documented, and available data concerning historical trends in land use further illustrate this conversion (Kundell et al., 1989; McCrary and Kundell, 1997; Kolb, 2008). In fact, the US Census Bureau has reported that the State of Georgia can expect a net increase of 1 million people from 2005-2020 (Cambell, 1997). The anticipated increase in population, and the subsequent changes in land use, will certainly result in greater stress on Georgia's water resources. With anticipated, long-term growth, the impacts to water resources may be prolonged and occur incrementally over time. Thus, without a critical evaluation of proposed changes in land use, the future-anticipated impairment of a given watershed could be unrecognizable until at some threshold, a "breaking point" is reached. What constitutes a breaking point would be unique to a given watershed, but end results such as an irreversible loss in aquatic habitat, species, and water quality/function would be similar.

Four years ago, the USACE, Savannah District recognized the need to expand our cumulative impacts analysis when evaluating permit applications. The United State Council on Environmental Quality (CEQ) has defined cumulative effects as, "*the impact on the environment which results from the incremental impact of the action when added to past, present and reasonably foreseeable future actions, regardless of what agency or person undertakes such other actions*." (Council on Environmental Quality, 1978). By way of background, Section 404 of the Clean Water Act requires the USACE to regulate specific activities that result in the discharge of dredged or fill material into waters of the US. Prior to authorizing such activities, the USACE, Savannah District evaluates a proposed project relative to public comments, compliance with 404(b)(1) requirements, 31 public interest factors, and cumulative impacts.

For projects that are subject to USACE jurisdiction, the Savannah District utilizes best available information to evaluate cumulative impacts within a watershed. Typical cumulative impact evaluations include an analysis of wetlands and/or stream impacts, water quality, and aquatic resources. The Savannah District recognizes that new information is frequently published and made available. Therefore, our process is updated annually and includes the vetting of any new data that could be useful. The approach, which is outlined in subsequent sections of this text, is performed when a standard permit or regional permit action is evaluated relative to a given watershed located in the State of Georgia.

ESTABLISHING SCOPE OF ANALYSIS

Typically, our cumulative impact analysis for a permit action includes an evaluation of past, present and reasonably foreseeable future impacts within a watershed. Savannah District has scoped the watershed analysis relative to 8-digit Hydrologic Unit Codes (HUC) (US Geological Survey, 1994). There are 52, 8-digit HUC watersheds with some fraction of their basin located in the state (US Environmental Protection Agency, 2008). For linear projects with multiple impacts to waters of the US, the cumulative impacts analysis may require the evaluation of more than one 8-digit HUC. However, a majority of projects are contained within a single watershed. Every attempt is made to secure data derived at the watershed scale. However, use of historical data, coupled with the existence of geopolitical boundaries, often requires an additional analysis of

data relative to the 159 counties that comprise the state. Figure 1 provides an example of the incongruence that typically exists between county boundaries and an 8-digit HUC.

Figure 1. Altamaha Watershed (HUC: 03070106) and ten counties that comprise basin.

ESTABLISHING LANDCOVER BASELINE

In order to evaluate the relative magnitude of impacts to waters of the US, the Savannah District first establishes a baseline. We have identified a GADNR publication (i.e., Project Report 26), which differentiates land use using 1988-1990 aerial images (Georgia Department of Natural Resources, 1996). Landcover classes including emergent, scrub/shrub, and forested wetlands are reported in terms of acreage within a given county. This land use "snapshot" is then combined with USACE historical data to establish a first-cut, "baseline" assessment of past and present impacts to waters of the US. For validation purposes, data extracted from Project Report 26 is compared to GIS data published by the Natural Resource Spatial Analysis Laboratory (NARSAL) (Kramer, 2008). Typically, a reasonable level of agreement exists between the two data sets.

ESTIMATING HISTORICAL IMPACTS

Presently, the Savannah District relies on data from the Regulatory Analysis and Management System (RAMS) to quantify impacts that have occurred from 1990-2005 (Loechl, 1998). The archived RAMS impacts data was compiled and subsequently reported with respect to Georgia's counties. Thus, an analysis of RAMS data and data obtained from Georgia Report 26 can be normalized with respect to the counties that comprise a watershed. Table 1 illustrates an example of the data composite.

County	Wetland Acreage	Wetland Acres Permitted	Wetland Acres Mitigated
Appling	39,963	34	70
Evans	12,493	21	35
Glynn	134,011	211	1,497
Jeff Davis	23,394	3	4
Long	93,629	118	1,344
McIntosh	149,942	17	70
Montgomery	14,426	9	7
Tattnall	33,959	31	73
Toombs	21,718	3	2
Wayne	99,669	190	1,499
Total	623,204	637	4,601

Table 1. Wetland acreage, impacts and mitigation data for the counties that comprise the Altamaha Watershed.

Using Equation 1, the percent wetland impacts from 1995-2005 is calculated for each of the respective counties that comprise a watershed of interest.

Equation 1.

$$\%\,\text{Wetland Loss} = \left[1 - \left(\frac{\text{Wetland}_{\text{Acreage}} - \text{Wetland}_{\text{Permitted}}}{\text{Wetland}_{\text{Acreage}}}\right)\right] \text{X}\,100$$

Typically, an analysis of percent wetland impacts for each county results in values that range from 0.2%-0.01%. As would be expected, counties experiencing high growth rates during the ten year period would trend toward the greatest percent wetland loss. The acreage of mitigation achieved within the counties is also evaluated. As illustrated in Table 1, the acreage of wetland mitigation is typically higher than the amount authorized for impact. In fact, an analysis of the 1990-2005 RAMS data suggests that the sum of compensatory mitigation, which has been recorded in many counties, can actually be an order of magnitude greater than the authorized impacts (Table 1).

CHARACTERIZING PRESENT DAY CONDITIONS

In support of a cumulative impact analysis, the Savannah District also evaluates existing conditions within a watershed. This is primarily accomplished through the analysis and/or characterization of: (1) Existing waters of the US quantities; (2) Recently approved and pending USACE permit actions; (3) Characterization of 303(d) listed streams; and (4) Evaluation of proposed mitigation. The existing waters within a given watershed are typically estimated by the USACE using the NARSAL website (Kramer, 2008). For example, the NARSAL website reports that in 2005 the Altamaha Watershed contained approximately 240,615 acres of forest wetlands, 4,970 acres

of non-forested wetlands (fresh), and 7,389 acres of non-forested wetlands (salt). The Savannah District then contrasts the potential impacts of the proposed project, and recently permitted projects, with the NARSAL acreage data reported in 2005.

Evaluating the proposed project with respect to 303(d) listed waters is accomplished by first identifying all impaired waters in a watershed. The USEPA maintains an online database that identifies 303(d) listed waters within 8-digit HUC watersheds (US Environmental Protection Agency, 2008). The intended use of a proposed project *and* distance between the site and listed waters is also considered in our evaluation. The USACE evaluation of water quality impacts is valuable when addressing cumulative impacts. However, it is important to note that the Georgia Environmental Protection Division (GAEPD) conducts an independent water quality review with respect to a proposed project. Upon receiving a successful review, the GAEPD issues 401 Water Quality Certification as defined by the Authorizing Statute OCGA 12-5-20 (Georgia Environmental Protection Division, 2008).

For the cumulative impact investigation of present-day activities, a proposed project is finally evaluated on the merits of the mitigation plan. The goal of the USACE's regulatory program is to establish "no net loss" of aquatic resources within a given watershed (Dunlop, 2007). To accomplish this goal, acceptable mitigation must include "in kind/in basin" replacement of the resource being impacted. Traditionally, applicants utilize the Savannah District's Standard Operating Procedure (SOP) to calculate the required credits needed to compensate for impacts to waters of the US (US Army Corps of Engineers, 2004). In brief, credits represent a common denominator when considering the value of impacted aquatic resources and the required mitigation. Internal to the SOP, factors such as temporal loss, degree of impact, resource characteristics, etc. are considered when assigning credit values. Presently, the use of mitigation banks represents the primary means of mitigating impacts (US Army Corps of Engineers, 2008). When the required credits are known, compensatory mitigation is sought at a mitigation bank with a service area that encompasses the proposed project site. Service area is typically defined on a watershed scale. Thus, a requirement for appropriate service area and use of banks with similar vegetation strata ensures "in kind/in basin" mitigation. From a cumulative impact perspective, the use of appropriate mitigation also ensures that the watershed of interest achieves "no net loss" of aquatic resources.

A robust mitigation plan does not ensure a project will be authorized by the USACE. Applicants must also demonstrate that a proposed project satisfies the sequential steps defined in the 404(b)(1) analysis (USEPA, 2006). Please note: The successful completion of the 404(b)(1) analysis constitutes one of the criteria that must be achieved prior to USACE issuance of a Section 404, CWA standard permit. Like the cumulative impact analysis, the results of the 404(b)(1) are included in a stand alone section of the Environmental Assessment (EA).

FUTURE ANTICIPATED IMPACTS

Evaluating future anticipated impacts to waters of the US is a necessary component of the cumulative impact assessment (Council on Environmental Quality, 1978). However, predicting future anticipated impacts can be difficult. Researchers continue to develop and evaluate complex models that do provide a means for predicting future aquatic impacts. The models, however, are often very intricate and typically require users to measure a large number of input parameters from a basin of interest. Regulations and permitting authorities require resource managers and regulators to make lasting decisions within certain time limits. Thus, the quandary continues with respect to researchers developing highly sophisticated models and resource managers not having user-friendly tools to aide in a timely, decision- making process.

Urbanization is often linked with an increase in impervious surface coverage (Dougherty et. al., 2004; Cappiella and Brown, 2001; Schuler 1994). Consequently, research on this subject has also demonstrated that an increase in impervious surface coverage can result in greater direct and indirect impacts on aquatic resources such as wetlands, water quality and aquatic species (Holland *et. al.* 2004; Wang *et. al*., 2000; Booth and Jackson, 1997). Direct impacts would be classified as the actual conversion of aquatic habitats to a different type land use. The result would be the immediate loss of the habitat from the watershed. In most cases, the loss of aquatic habitat results in increased impervious surface coverage. Indirect impacts to aquatic habitat would result from increased impervious surface coverage in areas that are not classified as aquatic by nature, but the upland-based, change in land use results in loading of non-point source discharges or loss of hydrology in adjacent aquatic areas. Given the resulting effects, knowledge of future-anticipated quantities of impervious surface coverage are certainly valuable for regulatory entities and/or resource managers.

The Savannah District methodology for evaluating future-anticipated impacts on aquatic resources is based largely on population growth and impervious surface coverage. Specifically, our approach is derived from the work conducted by the US Environmental Protection Agency (USEPA) (Exum *et al.*, 2005). The Savannah District worked closely with USEPA to generate a data set for the State of Georgia that reflects percent impervious surface coverage with respect to 12-Digit HUCS and the 159 counties in the year 2000. GIS software was then utilized by the Savannah District to calculate the weighted average

of percent impervious surface coverage that exists within 50 random counties. It should be noted that the selected counties represented a wide range of values for percent impervious surface coverage. The values were then plotted with respect to county populations per square mile that was also reported in the year 2000 (Figure 2). Population data was obtained from a database maintained by Texas A&M University (Texas A&M University, 2008).

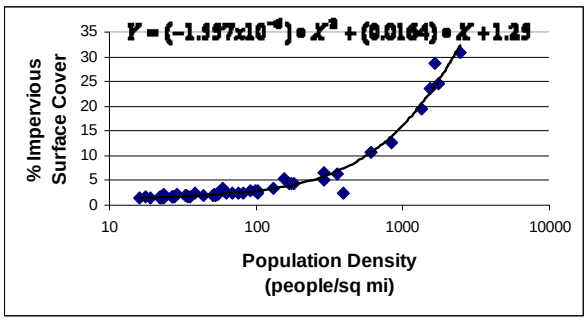

Figure 2. Percent impervious surface coverage as a function of population per square mile. Data was evaluated using non-linear regression analysis.

Once the relationship between percent impervious surface coverage and population density was determined, the Savannah District began evaluating population trends within each of Georgia's counties. Presently, the Georgia population data from 1990-2007 is normalized with respect to county area and evaluated with respect to time. Plots of the data are then evaluated using linear regression analysis. Figure 3 illustrates an example analysis conducted for Long County.

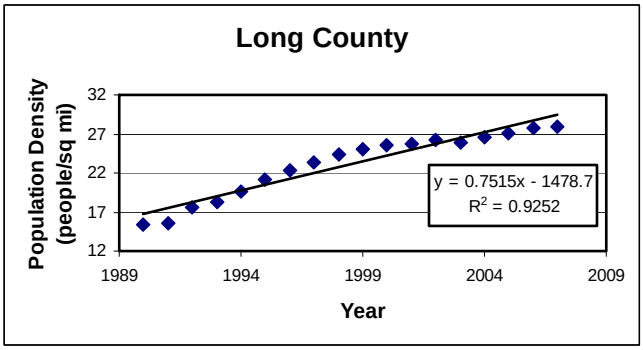

Figure 3. Population density as a function of time for Long County, Georgia. Linear regression analysis was conducted to determine trends in population growth.

Using the equation that was generated, an estimate of future-anticipated population projections can be obtained (Figure 4).

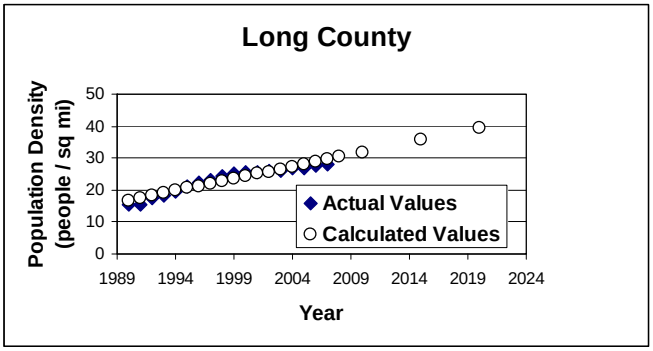

Figure 4. Estimates of population densities that might be anticipated if the present rate of citizen recruitment continues

Once future anticipated population densities have been estimated for all of the counties that comprise a watershed, the estimated values for future-anticipated, percent impervious surface coverage are calculated using the equation identified in Figure 2. Finally, the estimated future-anticipated, percent impervious surface coverage within each of the counties is reported with respect to year (Table 2).

County		Year				
		2007	2008	2010	2015	2020
Appling	Population / square mile	35.04	35.60	36.09	37.35	38.60
	% Impervious Surface Coverage	1.82	1.83	1.84	1.86	1.88
Evans	Population / square mile	61.55	63.64	65.56	70.36	75.10
	% Impervious Surface Coverage	2.25	2.29	2.32	2.40	2.47
Glynn	Population / square mile	128.50	126.26	128.47	134.02	139.56
	% Impervious Surface Coverage	3.33	3.30	3.33	3.42	3.51
Jeff Davis	Population / square mile	39.61	39.56	39.99	41.03	42.13
	% Impervious Surface Coverage	1.90	1.90	1.90	1.92	1.94
Long	Population / square mile	28.00	30.23	31.73	35.50	39.25
	% Impervious Surface Coverage	1.71	1.74	1.77	1.83	1.89
McIntosh	Population / square mile	19.86	20.49	21.06	22.49	23.93
	% Impervious Surface Coverage	1.58	1.59	1.59	1.62	1.64
Montgomery	Population / square mile	36.63	37.20	38.04	40.12	42.20
	% Impervious Surface Coverage	1.85	1.86	1.87	1.91	1.94
Tatnall	Population / square mile	47.46	49.52	50.85	54.19	57.52
	% Impervious Surface Coverage	2.02	2.06	2.08	2.13	2.19
Toombs	Population / square mile	75.45	74.78	75.82	78.42	81.02
	% Impervious Surface Coverage	2.48	2.47	2.48	2.53	2.57
Wayne	Population / square mile	44.76	45.35	46.47	49.28	52.09
	% Impervious Surface Coverage	1.98	1.99	2.01	2.05	2.10

Table 2. Predicted future-anticipated population densities and corresponding calculated values for percent impervious surface coverage.

Equation 2 is then utilized to calculate the percent increase in percent impervious surface coverage that could potentially be anticipated by the year 2020.

Equation 2.

$$\%\ \text{Increase} = \left[\frac{\%\ \text{Impervious}_{2020} - \%\text{Impervious}_{2008}}{\%\ \text{Impervious}_{2008}} \right] X\ 100$$

The use of Equation 2 to evaluate the anticipated percent increase in percent impervious surface coverage has been utilized on approximately 99 counties that constitute watersheds with boundaries in the State of Georgia. The frequency of calculated percent increase for percent impervious surface coverage is illustrated in Figure 5.

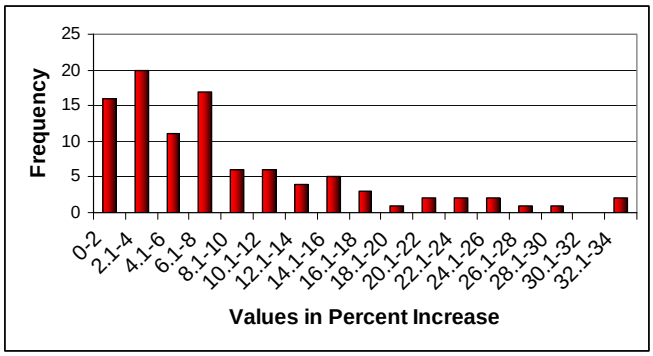

Figure 5. Frequency of calculated values in percent increase from 2008-2020 for percent impervious surface coverage. Values were obtained from approximately 99 counties that constitute watersheds with boundaries in the State of Georgia

Of the counties evaluated, 10 are anticipated to experience more than a 20% increase in percent impervious surface coverage by 2020. Such an increase would be indicative of dramatic rates in land use changes within these counties and ultimately the corresponding watersheds.

CONCLUSIONS

The methodology presented in this paper provides the USACE, Savannah District with a reasonable approach to evaluating cumulative impacts (past, present and future-anticipated) to water resources that are located within a given watershed. The current inability to retrieve 2006-2008 (i.e., present day) data is a challenge. In 2006, the Savannah District migrated from use of the RAMS database to the OMBIL Regulatory Module (ORM). Once completely operational, the updated data base will allow for retrieval of spatial and quantitative data specific to impacts and mitigation. This capability of the Corps' new data base will greatly improve our ability to assess cumulative impacts that occur within a watershed.

The results illustrated in the "Future Anticipated Impacts" section are of interest. No doubt it is difficult to predict the future, but there is currently a need to accurately evaluate growth trends in the State of Georgia. From the standpoint of environmental sustainability, knowing future-anticipated growth trends greatly enhances the ability of regulatory agencies to encourage communication among stakeholders. For example, one could envision a proposed project, which included impacts to water resources, in an area forecasted to experience greater than 20% increase in percent impervious surface coverage over the next 10 years. Having the best available data, the resource agencies would be in a position to approach the applicant, local government, and/or public with concerns prior to rendering a permit decision. Thus, mandating strategies for improving project design and reducing environmental impacts are better justified.

In addition, knowing the projected needs of a watershed will greatly enhance the resource agencies' ability to target limited resources for environmental restoration projects. That point is illustrated with the implementation of new mitigation rules adopted by the USACE and USEPA. The new rules identify mitigation banking and In Lieu fee as the primary and secondary means, respectively, of mitigating impacts to waters of the US (US Army Corps of Engineers, 2008). Thus, projecting future development trends would help with the identification of sites where restoration and preservation projects generate the greatest value.

As with any scientific pursuits focused on environmental sustainability, our goal is to advance our current process of evaluating permit applications. The Savannah District recognizes the need to continuously identify additional data sets and/or utilize more robust tools in support of the decision making process. We are aware of many initiatives being developed to evaluate cumulative impacts and changes in land use. As that information becomes available, the USACE will make every attempt to integrate the best available data and analysis into our methodology.

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