



Department of
Environmental
Conservation

Part 490, Projected Sea-Level Rise - Regulatory Impact Statement

Regulatory Impact Statement

6 NYCRR Part 490, Projected Sea-level Rise

INTRODUCTION

On September 22, 2014, Governor Cuomo signed into law the Community Risk and Resiliency Act, Chapter 355 of the Laws of 2014 (CRRA). CRRA is intended to ensure that decisions regarding certain State permits and expenditures consider climate risk, including sea-level rise. Among other things, CRRA requires the Department of Environmental Conservation (Department) to adopt regulations establishing science-based State sea-level rise projections. Therefore, the Department is proposing to establish a new 6 NYCRR Part 490, Projected Sea-level Rise (Part 490). Part 490 will establish projections of sea-level rise in three specified geographic regions over various time intervals, but will not impose any requirements on any entity.

STATUTORY AUTHORITY

The statutory authority to promulgate Part 490 is found in Environmental Conservation Law (ECL) § 3-0319, which was added by CRRA. ECL § 3-0319 requires the Department to adopt regulations establishing science-based State sea-level rise projections by January 1, 2016. The promulgation of Part 490 by the Department will fulfill this statutory requirement. ECL § 3-0319 also requires the Department to update such regulations no less than every five years, which the Department will do through future action.

LEGISLATIVE OBJECTIVES

CRRA was enacted with the purpose of ensuring that decisions regarding certain State permits, regulations, and expenditures include consideration of the effects of climate risk, including sea-level rise and extreme weather events. Part 490 will implement one component of this objective by providing a common source of sea-level rise projections for consideration within the programs specified by CRRA. The adoption of Part 490 is the first step in the overall process to implement CRRA, as the Department is also currently preparing guidance, in consultation with the Department of State, regarding the implementation of CRRA. This guidance will address, among other things, how consideration of the sea-level rise projections in Part 490 should be incorporated into each of the permitting and other programs enumerated in CRRA. CRRA requires this guidance to be adopted by January 1, 2017. Finally, applicants for relevant permits or funding programs will not be required to consider Part 490's sea-level rise projections pursuant to CRRA until such guidance is adopted.

NEEDS and BENEFITS

CRRA enumerates several permitting, regulatory and funding programs in which the applicants, the Department, or other relevant State agencies shall be required to consider future climate risk, including sea-level rise. CRRA also amends the State Smart Growth Public Infrastructure Policy Act, ECL Article 6, to add an additional smart growth criterion regarding mitigation of future climate physical risk. Adoption of Part 490 will help to ensure that sea-level rise projections are incorporated into decision-making processes in a consistent, transparent manner and will contribute to regulatory certainty.

Stakeholder Outreach

The Department conducted outreach to stakeholders in several fora prior to proposing Part 490. This outreach included interaction with the authors of various reports regarding sea-level rise in order to gain understanding of

the most current and applicable science. For example, the Department held a teleconference with the authors of two reports on March 6, 2015. Moreover, the Department held individual discussions with certain particularly interested stakeholders, such as the City of New York on June 1, 2015. In addition, the Department's stakeholder outreach included five public informational and listening sessions, at which Department staff presented background on CRRA and the scientific information the Department considered in developing Part 490. These meetings were advertised through Departmental press release and in the Department's Environmental Notice Bulletin, and were held on June 23-25 at locations in Albany, New York City, and Nassau and Suffolk Counties. At these meetings, the Department received input from stakeholders on Part 490.

Summary of Projection Format

Based in part on this input, the Department proposes to adopt in Part 490 five sea-level rise projections for each of three regions of the State. The three regions of the State are Long Island, New York City and the Lower Hudson River upstream to Kingston, and the Mid-Hudson River from Kingston upstream to the federal dam at Troy. These three regions exhibit small differences in relative sea-level rise due to local conditions. The five projections for these three regions are low, low-medium, medium, high-medium and high. These qualitative terms refer to the rate of rise, not to ultimate water levels, as warming of the Earth system has already resulted in a long-term commitment of at least six feet of global sea-level rise above current levels (Strauss, 2013¹). In other words, while there is some uncertainty regarding the precise rate at which sea level will rise, there is relative certainty that global sea level will ultimately rise at least six feet over current levels. Finally, each of these projections is presented for four different time periods: the 2020s, 2050s, and 2080s, and the year 2100.

Revisions to Part 490

The Department made substantial revisions to Part 490 in response to public comments received on the initial notice of proposed rulemaking. First, the Department substantially revised the definition of "high projection" in subdivision 490.3(i). Pursuant to this revision, in addition to being "very unlikely" to occur, the "high projection" is defined as being "associated with high rates of melt of land-based ice." This revision is intended to acknowledge the fact that, if the high projection is reached by a given time interval, it would be associated with high rates of melt of land-based ice. Second, the Department substantially revised the definition of the term "low projection" in subdivision 490.3(m). Pursuant to this revision, in addition to being "very likely" to be exceeded, the "low projection" is defined as being "consistent with historical rates of sea-level rise." This revision accounts for the fact that future sea-level rise is not projected to be consistent with historical trends, but is instead projected to accelerate with increased warming. In addition, the Department made changes to Sections 490.1 and 490.2 to expand upon the purpose and applicability of Part 490.

ClimAID Report

The Department's proposed sea-level rise projections in Part 490 are based on sea-level rise projections included in Horton et al. (2014²), prepared for the New York State Energy Research and Development Authority, also known as the ClimAID report. ClimAID provides model-based projections of sea-level rise for three regions of the State for three intervals of time (2020s, 2050s, 2080s) and for the year 2100. Each of the time intervals is centered on the given decade, e.g., 2020s refers to the years 2020 through 2029. The ClimAID report provides these projections for three different tide gauge locations. The sea-level rise projected by the ClimAID report is shown in Table 1 below.

Table 1. ClimAID sea-level rise projections (inches of rise relative to 2000-2004 baseline).

Tide Gauge	Montauk Point				New York City				Troy			
	Percentile											
Time Interval	10th	25th	75th	90th	10th	25th	75th	90th	10th	25th	75th	90th
2020s	2	4	8	10	2	4	8	10	1	3	7	9
2050s	8	11	21	30	8	11	21	30	5	9	19	27

2080s	13	18	39	58	13	18	39	58	10	14	36	54
2100	15	21	47	72	15	22	50	75	11	18	46	71

ClimAID's projections are based on the outputs of more than 20 global climate models, downscaled to New York, using the Intergovernmental Panel on Climate Change's (IPCC) Representative Concentration Pathways (RCP) 4.5 and 8.5 as inputs. RCP 4.5 describes a scenario in which global greenhouse gas emissions increase only slightly before declining around the year 2040, leading to a stabilization of atmospheric greenhouse gas concentrations shortly after the year 2100. RCP 8.5 assumes no significant global greenhouse gas emission-reduction policies are implemented and emissions increase, leading to higher atmospheric greenhouse gas concentrations.

ClimAID's projections also incorporate additional information, e.g., expert judgment, to account for anticipated changes in rates of ice melt that cannot yet be more rigorously included in quantitative models. The methods used by Horton et al. (2014³) are identical to those used to generate sea-level rise projections for the New York City Panel on Climate Change (NPCC) and are described in more detail in Horton et al. (2015⁴) and NPCC (2015⁵). The percentiles provided in Table 1 refer to the range of model outputs as reported by ClimAID, e.g., 90th-percentile means that 90 percent of the model outputs were equal to or less than that projection and 10 percent of the model outputs were greater.

The Department is basing its proposed low, low-medium, high-medium and high projections for the three regions of the State on the 10th, 25th, 75th and 90th percentiles of ClimAID model outputs, respectively. The medium projection represents the 50th percentile of ClimAID's model outputs, calculated as the average of the 25th - and 75th-percentile outputs. Stakeholders suggested that the Department add a 50th-percentile projection as many New York City agencies are using the 50th-percentile projection in their operational planning.

Comparison of ClimAID Report to Other Reports

As required by ECL § 3-0319, the Department considered various sources of information in proposing to adopt projections in Part 490 based on the ClimAID report. This includes projections prepared for the National Climate Assessment (NCA) and the New York State Resiliency Institute for Storms and Emergencies (RISE). In reviewing these reports, the Department considered factors such as the degree to which the projections accounted for local and regional variation, whether the projections covered the entire tidal coast of the State, and the way in which the projections accounted for uncertainty regarding the rate of ice melt in the future.

Sea level rose along the U.S. east coast at rates of 0.34 to 0.43 inches per decade prior to the Industrial Revolution (Gehrels, et al., 2005⁶; Donnelly et al., 2004⁷). This relative rise was due primarily to subsidence of the surface as the Earth's crust adjusted to glacial retreat. At the time of the Industrial Revolution, however, regional sea level began to rise more rapidly than it had for the previous millennium as ocean waters began to warm and expand (Holgate and Woodworth, 2004⁸). Extrapolating recent rates of global sea-level rise yields an estimate of approximately eleven inches of rise by 2100. However, scientists project that as the ocean continues to accumulate excess heat due to global warming, sea-level rise due to thermal expansion will continue. Further, as the atmosphere warms, the contribution to sea-level rise by the melting of alpine glaciers and ice sheets, particularly on Greenland and Antarctica, will become the dominant component of global sea-level rise, leading to acceleration of rise into the future.

Parris et al. (2012⁹) generated four global sea-level rise scenarios for use in the NCA through a synthesis of prior assessments. These researchers did not ascribe probabilities or likelihoods to the four scenarios and cautioned that decision makers should not use any of the four scenarios in isolation. Rather, the entire range of possible global sea-level rise should be incorporated into decision making. Although the researchers did not assign probabilities to any of the four scenarios, they expressed "very high confidence (>9 in 10 chance) that global mean sea level will rise at least 0.2 meters (8 inches) and no more than 2.0 meters (6.6 feet) by 2100."

Local sea-level rise reflects not only global sea-level rise but also regional and local factors, such as local changes in rise and fall of land and regional oceanographic changes. Therefore, it is important to note that the NCA projections are for global sea level-rise, and do not account for regional and local factors along the New York coast. Regional and local factors combine to result in greater sea-level rise along the New York coast than occurs globally. New York State sea-level rise has averaged 1.2 inches per decade since 1900, compared to the observed global rate of rise of 0.7 inches per decade over the same period (Rosenzweig et al., 2011¹⁰).

Table 2 provides a comparison between projections developed by the NCA and corresponding ClimAID projections for the New York City/Lower Hudson region. The ClimAID projections are relatively consistent with the NCA projections.

Table 2. Comparison of projected sea-level rise under four National Climate Assessment scenarios and corresponding ClimAID projections for New York City/Lower Hudson.

National Climate Assessment (Subtract one inch for direct comparison to ClimAID's 2002 baseline)		ClimAID New York City/Lower Hudson	
Scenario	inches of rise relative to a 1992 baseline	Percentile	inches of rise relative to a 2002 baseline
Highest	79	90th	75
Intermediate- High	46	75th	50
Intermediate- Low	19	25th	22
Lowest	8	10th	15

Although the ClimAID and NCA projections are similar, it is appropriate to base State projections on research that includes regional and local factors, because these factors can have a significant effect on local sea-level rise.

Zhang et al. (2014¹¹), otherwise known as the RISE report, modeled sea-level rise for Montauk Point, Suffolk County and the Battery, New York City for the RISE. This report generated projections for portions of the Long Island coast by interpolating model results between Montauk Point and the Battery. RISE reported projections for the 2020s, 2050s and 2080s, but has provided time series data for New York City through 2100 for comparison with ClimAID projections (Table 3). The RISE projections were based on methods similar to those used by ClimAID, but RISE reports the results of sea-level rise models run under RCP 4.5 and RCP 8.5 separately and does not provide projections for the Hudson River. RISE model outputs are dominated by RCP 4.5 in the lower projection ranges and by RCP 8.5 at higher ranges.

Table 3. Reported projected sea-level rise, New York City (inches of rise relative to 2000-2004 baseline): New York State Resiliency Institute for Storms and Emergencies.

Time Interval	Percentile		
	10th (RCP 4.5)	50th (RCP 8.5)	95th (RCP 8.5)
2020s	3	6	11
2050s	7	16	24
2080s	NA	28	40
2100	14	35	48

RISE and ClimAID low and medium projections are comparable, but RISE projections are significantly lower than the ClimAID projections under high emissions scenarios. For example, RISE's 95th-percentile projection of 48 inches at the Battery by 2100 may be compared to ClimAID's 90th-percentile projection of 75 inches (Table 4).

Table 4. Comparison of High Projected Sea-level Rise Projections, New York City (inches of rise relative to 2000-2004 baseline): ClimAID and New York State Resiliency Institute for Storms and Emergencies.

Time Interval	ClimAID 90 th -percentile	RISE 95 th -percentile
2020s	10	11
2050s	30	24
2080s	58	40
2100	75	48

The difference between the ClimAID and RISE projections is due primarily to differences between projections of the sea-level rise effect of dynamical changes in land ice, particularly on Greenland and Antarctica, and of surface melt of ice on Greenland. The differences in projections arise from the use of different methods to project these components of sea-level rise (Radley Horton, Minghua Zhang; pers. comm.). RISE bases its projections of these components on IPCC process-based models, which are conservative and do not include the potential for rapid increases in the rate of ice melt. ClimAID assumes these rates will increase with global warming and applies semi-empirical methods that are based on reconstructions of the past relationship between sea level and global temperature. Even semi-empirical methods do not include the sea-level rise effect of a large, singular event, such as collapse of an ice sheet, which could cause even greater increases in sea-level rise.

Given that 6 feet of sea-level rise during the next century cannot be ruled out, and the potential consequences of such rise, the Department is proposing to base Part 490 on the ClimAID projections, including a high projection consistent with ClimAID's 90th-percentile projection. An alternative is to base Part 490 on the RISE projections, which do not include the possibility of high rates of sea-level rise or the potential for low-probability but highly consequential events. Basing Part 490 on the RISE projections would increase the probability of decisions that do not fully consider the possibility of higher sea-level rise that could occur with rapid ice melt. Moreover, as noted above, six feet of sea-level rise is likely to occur at some point in the future, even if the precise timing of such rise is uncertain.

The Department acknowledges that the highest projections developed by some other studies for New York City are lower than the ClimAID high projections. For example, Kopp et al. (2014¹²) project very likely ranges of sea-level rise for New York City by 2100 of 13 to 48 inches and 17 to 60 inches for RCP 4.5 and RCP 8.5 respectively, compared to the ClimAID 90th-percentile projection of 75 inches. Both Kopp et al. and ClimAID incorporated projections of West Antarctic ice melt generated by Bamber and Aspinall (2013¹³), but in different ways. Bamber and Aspinall had attempted to address suggestions that sea-level rise attributable to ice sheet melt was underestimated by pooling expert views on uncertainties in future ice-melt contributions. Kopp et al. reconciled the projections of West Antarctic ice sheet melt generated by Bamber and Aspinall to the IPCC Fifth Assessment Report (AR5) projections, which do not include potential rapid ice sheet deterioration, by applying multipliers to the Bamber and Aspinall range. This approach eliminated low, but non-zero, probability ranges from Kopp et al.'s projections and eliminated consideration of accelerating melt rates. On the other hand, Horton et al. (2014¹⁴) surveyed 90 experts, which yielded higher projections of global sea-level rise at higher emissions levels (RCP 8.5) than had been projected by Kopp et al. or AR5. Kopp et al. suggest this result may be related to expert expectations about future Antarctic ice melt. It is worth noting that 75 inches of sea-level rise, ClimAID's high New York City projection for 2100, falls within Kopp et al.'s likely range for New York City by 2150, under RCP 8.5, of 43 to 79 inches.

While there are differences among the highest projections for sea-level rise, based largely on the manner in which projections account for the potential for rapid ice melt, the question of the future contribution of ice melt, particularly from Greenland and Antarctica, is one of the most important facing scientists studying sea-level rise. Bamber and Aspinall (2013¹⁵) surveyed the same sea-level rise experts in 2010 and 2013 regarding future ice-sheet contributions. At least three of the 13 respondents significantly increased the upper bounds of their projections from the first survey to the second and the authors concluded the results indicate "a growing view

that a significant marine ice-sheet instability in the WAIS [West Antarctic Ice Sheet] could initiate in the coming century." Although the Department recognizes uncertainty regarding the rate of future ice melt, it is appropriate to allow for consideration of the potential for more rapid ice melt, as explained in more detail below.

Reasons for Basing Projections on ClimAID Report

The Department has considered numerous factors in proposing to base Part 490 on the ClimAID projections rather than on more conservative, less protective projections based primarily on process modeling.

First, adoption of projections based on the ClimAID report ensures that regulators, planners and others have access to projections developed specifically for New York State and accounting for regional and local factors not considered in development of global sea-level rise projections.

Second, the ClimAID research was conducted by the same research team that provided the NPCC projections, using the same methodologies, which have been peer reviewed and published in established scientific journals. New York City has already adopted the NPCC/ClimAID projections for its planning purposes; a State regulation based on alternative projections could create confusion among the public, planners and regulated community.

Third, ClimAID provides projections for the entire tidal coast of the state including the Hudson River upstream to the federal dam in Troy, rather than just Long Island and New York City.

Fourth, the proposed projection distribution (low, low-medium, medium, high-medium and high) constitutes a range suitable for risk-based planning and review of projects of varying projected life times and criticality. By having a full range of projections that include a high-medium and high value, decision makers will be able to consider the possibility of more rapid sea-level rise as it relates to particular projects in the context of relevant programs under CRRA.

Fifth, this projection distribution has been useful to communities conducting adaptation planning along the Hudson River.

Inclusion of Higher Projections of Sea-level Rise

The Department acknowledges that ClimAID's 75th- and 90th-percentile projections include estimates of the contribution of land ice melt, and that these estimates incorporate some amount of uncertainty. Some of this uncertainty is due to the nature of making any projections about the future, including regarding the rate of sea-level rise, rather than basing figures solely on historical data. In Part 490, these 75th- and 90th-percentile projections correspond to high-medium and high projections. As defined in Part 490, these two projections are unlikely and very unlikely to be exceeded by the specified time interval, respectively, meaning that decision makers will be able to consider these projections as appropriate for the particular project.

Similarly, it is possible that the inclusion of higher projections of sea-level rise could lead to consideration of conditions that are unlikely to occur, at least in the more immediate future. However, decision makers should at least consider the potential consequences of future events about which scientific uncertainty remains. Adoption of several levels of projections allows for consideration of risk tolerance in decision making. The high-medium or high projections might be used for long-term projects for which there is low risk tolerance, for example, while lower projections may be appropriate for consideration in situations in which risk tolerance is high. Inclusion of unlikely but plausible projections provides benchmarks against which long-term decisions, e.g., those regarding critical infrastructure and land-use change, can be evaluated for low-probability but high-consequence events. If Part 490 did not include higher projections of sea-level rise, then decision makers would not be able to even consider the possibility of such levels occurring.

Furthermore, Hinkel et al. (2015¹⁶) warn that sea-level rise projections based on process-based models, such as those used by IPCC and RISE, are primarily intended for the purpose of understanding earth system physics and are not appropriate for risk-based decision making as they do not fully incorporate the effects of accelerated ice melt. They warn that projections based on the IPCC AR5 projections of mean global sea-level rise of 11 to 39

inches by 2100 may not be adequate for risk management due to the intolerably high residual risk associated with rapid ice melt. Parris et al. (2012¹⁷) also cautioned that focusing only on the most probable outcome could lead to vulnerability or maladaptation. Decision makers, including residents and local leaders, should understand the full range of potential risk. Communities and stakeholders in New York State that have been presented with the ClimAID projections have tended to adopt and plan for high levels of sea-level rise rather than more moderate levels. These stakeholders have placed a high degree of importance on ensuring the viability of proposed infrastructure investments and the social and economic fabric of their communities from even unlikely eventualities.

The Department acknowledges that RCP 8.5, under which the highest sea-level rise projections were generated, may be averted by global action to reduce greenhouse gas emissions. However, this factor must be weighed against research published since the ClimAID projections were released that indicate even greater rates of sea-level rise are occurring. For example, Carling et al. (2015¹⁸) determined that the rate of global sea-level rise during the past two decades had been significantly higher than previously believed and concluded that revising the rate of rise to reflect more recent rise would affect some sea-level rise projections upward. In any case, as explained above, the higher sea-level rise projections are defined in Part 490 as being unlikely or very unlikely to be exceeded by the specified time interval, and may be considered as appropriate for the particular project at issue.

Finally, as explained above, sea-level rise will continue for many centuries as the earth system comes into equilibrium over many centuries or even millennia. Thus, as noted above, the question for decision makers is not if a critical sea level will be reached, but when. Strauss (2013¹⁹) calculated that historic emissions have already committed the globe to a mean sea-level rise of 6.2 feet. Levermann et al. (2013²⁰) estimated that the current international target of 2°C warming will result in an eventual mean global sea-level rise of more than 15 feet after 2000 years. Even some more conservative projections of rates of sea-level rise, e.g., the RISE 50th-percentile RCP 8.5 projection, indicate sea-level rise of approximately six feet within the next 150 years. Thus, a full range of projections in Part 490 that includes higher values is appropriate to allow for consideration of a level of sea-level rise that will likely occur at some point, even if the timing of such occurrence is uncertain.

COSTS

Part 490 will not impose any costs on any entity because the regulation consists only of sea-level rise projections and does not impose any standards or compliance obligations. In other words, while Part 490 will provide a common source of sea-level rise projections for consideration within programs specified by CRRRA, it will not impose any requirements on any entity. Therefore, there are no costs associated with Part 490. Likewise, the regulation will also not impose any additional costs on the Department or local government entities.

LOCAL GOVERNMENT MANDATES

Part 490 will not create any mandates for local governments, including any additional recordkeeping, reporting, or other requirements.

PAPERWORK

No additional record keeping, reporting, or other requirements will be imposed under this rulemaking.

DUPLICATION

This proposal does not duplicate, overlap, or conflict with any other existing federal or State regulations or statutes.

ALTERNATIVES

Alternatives to this proposal include: (1) No action, or not establishing Part 490, (2) basing the projections in Part 490 on scientific reports other than the ClimAID report, and (3) using an alternative projection format.

1) No Action - Not establishing Part 490 is not an available alternative because ECL § 3-0319 requires the Department to adopt a regulation establishing science-based State sea-level rise projections.

2) Other Reports - The Department considered basing its proposed projections on several alternative scientific reports other than the ClimAID report, including Parris et al., (2012²¹), completed for the NCA, and Zhang et al., prepared for RISE (2014²²). The Department also reviewed and considered information contained in reports of the IPCC (Church et al., 2013²³), New York State Sea Level Rise Task Force²⁴ and the NPCC.²⁵ The Department rejected basing the projections in Part 490 on any of these other reports because, among other reasons and as explained above in the Needs and Benefits section, the ClimAID report covers the entire tidal coast of the State, accounts for local and regional variations in sea-level rise, and incorporates the possibility of rapid ice melt.

3) Other Formats - The Department considered using a different projection format in Part 490. For example, the Department considered including projections for different geographic regions or time intervals, or including a different range of projections. The Department is proposing Part 490 in a format that includes five projections for each of three geographic regions based on stakeholder input and because it is consistent with the format of the ClimAID report.

FEDERAL STANDARDS

There are no federal rules or other legal requirements relevant to Part 490. Therefore, this proposal does not result in the imposition of requirements that exceed any minimum standards of the federal government for the same or similar subject areas.

COMPLIANCE SCHEDULE

There is no compliance schedule required by the establishment of Part 490 because the rule does not impose any compliance obligations on any entity.

Footnotes

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