# Morphologic Change by Overwash: Establishing and Evaluating Predictors

Donnelly, Chantal

*Published in:*
Journal of Coastal Research

2007

| Journal of Coastal Research | SI 50 | 520 - 526 | ICS2007 (Proceedings) | Australia | ISSN 0749.0208 |
|---|---|---|---|---|---|

# Morphologic Change by Overwash: Establishing and Evaluating Predictors

**C. Donnelly†**
†Water Resources Engineering
Lund University, Lund
22100, Sweden
Chantal.donnelly@tvrl.lth.se

**ABSTRACT**

DONNELLY, C. Morphologic Change by Overwash – Establishing and Evaluating Predictors. Journal of Coastal Research, SI 50 (Proceedings of the 9th International Coastal Symposium), 520 – 526. Gold Coast, Australia, ISSN 0749.0208

The ability to predict cross-shore profile response to coastal overwash is important for both understanding how barrier islands respond to overwash and for disaster management on developed coastlines. This study establishes morphologic and hydrodynamic parameters for predicting the type of cross-shore profile response following overwash for given pre-storm profile and storm conditions. More than 50 data sets were categorised into 7 different types of cross-shore profile response to overwash. These responses are: 1) crest accumulation 2) landward translation of dunes/berms 3) dune lowering 4) dune destruction 5) barrier accretion 6) barrier rollover (short-term),and 7) barrier disintegration. Dimensionless parameters describing the pre-storm morphology and storm characteristics for these data sets were then plotted in two-dimensional space and trends for the different response types identified. For some responses it was possible to define criteria for their occurrence and for the others an approximate trend could be identified. Maximum surge level, maximum run-up level, storm overtopping duration, beach crest height, dune width and dune volume proved some of the most important parameters to distinguish responses. The criteria that are established and trends identified should allow the user to qualitatively predict the overwash response of a given cross-shore beach profile to a given set of storm conditions, using readily available data.

**ADDITIONAL INDEX WORDS:** *barrier islands, beach profiles, storm impacts, hurricane impacts*

## INTRODUCTION

Coastal overwash occurs when surge level or wave run-up height superimposed on surge level exceeds the beach crest height, causing the flow of water and sediment over the crest of the beach. Overwash typically occurs during tropical storms, hurricanes and cyclones, causing a hazard to coastal communities and infrastructure. The ability to predict the location and extent of overwash and overwash deposits, known as washover, is therefore an important tool for coastal development planning, storm response planning and for understanding how barrier islands respond to sea-level rise.

Overwash morphologies have typically been characterised based on the spatial extent and shape of washovers as viewed from the air (e.g. Price 1947, to Morton and Sallenger 2003). Such characterisations defined common washover morphology terms in use today, such as perched washover fans, washover terraces, sheet lineations and sheet-wash. Using a set of more than 110 beach profiles DONNELLY et al., (2007) showed that the cross-shore profile response to overwash can be categorised into 7 types, 1) crest accumulation, 2) landward translation of dunes/berms, 3) dune lowering, 4) dune destruction, 5) barrier accretion, 6) barrier rollover (short-term) and 7) barrier disintegration, shown in Figure 1. The purpose of this study was to associate these types of cross-shore morphologic changes with the morphologic conditions and hydrodynamic forcing in an attempt to qualitatively predict the cross-shore profile response to overwash.

More than 50 sets of pre-and post-storm profile data with the associated wave height, wave period and water level time-series were assembled, and used to test a variety of dimensionless parameters to estimate the overall response of a profile to an overwash event. The results show that it is possible to estimate the type of cross-shore response to overwash that will occur at a given location, for a given storm, using readily available data.

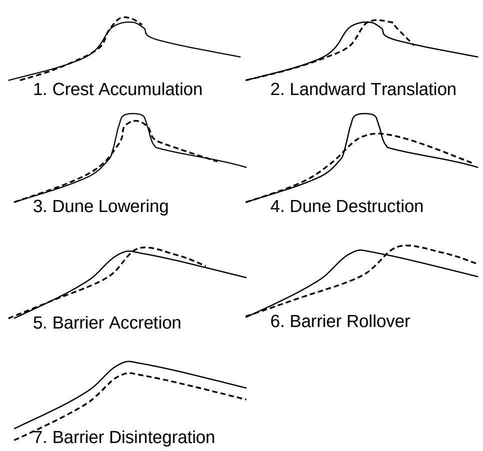


Figure 1. Cross-shore profile response to overwash types. Dotted line indicates profile after an overwash event.

## DATA

Sets of pre-and post-storm cross-shore profile data were assembled for locations where overwash had occurred. The profiles were compiled from published literature, from beach protection authorities, and from city, state and consulting engineers. The associated storm hydrodynamics, i.e. wave height and period and water level time-series, were also sought for the same locations, for the same period as that spanned by the pre- and post-storm profile surveys. A total of 55 complete data sets were assembled. The data sets are from Metompkin Island VI (BYRNES AND GINGERICH, 1987) Folly, Garden City and North Myrtle Beaches SC (EISER AND BIRKEMEIER, 1991), Assateague Island and Ocean City MD (WISE et al., 1996), Manasquan Beach NJ (WISE et al., 1996), Santa Rosa Island FL (STONE, 2004), St Lucie County FL, (CP&E, pers. comm.) Hatteras Island NC (USGS, pers. comm.), and three data sets were from an overwash field experiment on the Ria de Formosa, Portugal (MATIAS et al., 2003). All but these last three data sets were from the United States Gulf and Atlantic Coasts where overwash is relatively frequent and monitoring dense. The data sets are for sandy beaches only, hence the results are not applicable to gravel and shingle beaches.

The spatial extent of the profiles varies, particularly the landward extent of the profile surveys. For example, variables such as barrier width and overwash volume could not be defined because in some cases there was no closure at the landward end of the pre- and post-storm profile sets. Only pre- and post-storm profile surveys that extended at least to the landward base of the pre-storm dune were included in this study. The temporal extent of the pre- and post-storm profile measurements also varies and this was considered when evaluating the profiles.

For the Portuguese field experiment, detailed time-series of wave height, period and water level were measured. Otherwise, hourly time-series of significant wave heights and periods were either extracted from nearshore wave buoys, or where such data was unavailable, from WIS (Wave Information Studies) hindcasts for the time period spanned by the pre- and post-storm surveys. Water level time-series were taken from nearby tidal stations. Because the wave heights for each site were measured at different depths, the heights were reverse shoaled into deep water assuming linear wave theory and a shore normal wave approach on straight and parallel bottom contours. It is acknowledged that processes such as refraction and bottom friction are neglected but this simplified approach allows a quick and simple comparison of wave heights from different sites with a minimum data requirement.

Maximum significant deepwater wave heights ranged from 1.4 m to 14.9 m, wave periods from 9.1 – 17.1 s and surge levels including tidal variation from 1.7 – 2.8 m above MSL. Beach profiles ranged from low flat barriers with crest heights of less than 2 m above MSL to barriers with prominent dunes over 6 m above MSL. Grain sizes vary from 0.17 mm to 0.44 mm.

## METHODS

Each of the profile sets was categorised into one of the 7 profile response types defined by DONNELLY et al., (2007). The number of profiles for each response type is listed in Table 1. As there were so few profiles with hydrodynamic data for barrier rollover and barrier disintegration, these were grouped with barrier accretion to represent a cumulative *barrier* response type of cross-shore morphologic change, for which there were 9 profiles. The

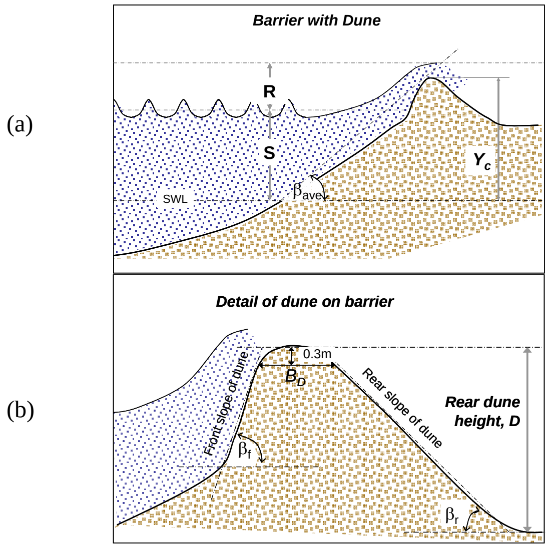


Figure 2. Schematic of (a) barrier (b) and detail of dune on barrier defining morphology parameters

barrier response type is not entirely defined by the pre-storm morphology. For example, a low flat barrier without a prominent dune may still undergo crest accumulation or landward translation of the beach crest.

It would be useful to be able to predict the occurrence of the different types of profile response to an overwash event through some simple, empirically based criterion using readily available data on the storm and beach profile conditions. Such a criterion preferably employs suitable non-dimensional parameters. A non-dimensional analysis of the problem was carried out. A large number of non-dimensional parameters were compiled using the Buckingham Pi theorem, so trial and error was used to establish which of these parameters were most suitable for predictive purposes.

A list of parameters, thought to affect profile response due to overwash, was made. Current knowledge of overwash processes, factors affecting overwash discussed by MORTON (2002), and hypotheses relating the hydrodynamic forcing to the profile response proposed by DONNELLY et al., (2007), were all taken into account. Additionally comparisons of profiles in the same region showing different types of profile response were made and important parameters inferred from the pre-storm morphology. Similarly, comparisons of profiles in different regions with similar responses were also used to infer important parameters.

The parameters proposed were either morphologic (describing the pre-storm profile) or hydrodynamic (describing the storm hydrodynamics). The morphologic parameters deemed important are defined by the pre-storm morphology and are beach or dune

Table 1: Distribution of profile data among cross-shore profile change types following overwash

| Cross-shore Profile change type | Number of Profiles |
|---|---|
| 1. Crest accumulation | 9 |
| 2. Landward translation | 7 |
| 3. Dune Lowering | 8 |
| 4. Dune Destruction | 22 |
| 5. Barrier Response | 9 |

(hereafter referred to as beach) crest level above mean sea level (MSL), $Y_c$, the foreshore slope, $s_{ave}$, dune front and rear slopes, $s_f$ and $s_r$, where $s = \tan\beta$, the dune height, $D$, and the width of the top of the dune, $B_D$.

Defining a foreshore slope for overwash was made difficult by the fact that run-up may occur on the foreshore and on the dune face, so an average slope between MSL and the beach/dune crest was defined, $s_{ave}$. The definition of the dune slopes, $s_f$, and $s_r$ is defined on Figure 2 and is somewhat subjective.

$D$ is defined as the rear dune height, i.e. the dune height on the landward side of the beach crest. A dune height defined on the seaward side was also considered, but this was more difficult to define as the break in slope is less obvious on the seaward side. Also, the rear dune height should affect the overwash type as it affects the volume of the dune and hence the amount of material available before the dune is destroyed. The dune slopes and $D$ are not defined for sites without dunes.

The dune width parameter, $B_D$ should represent the width at the top of the beach/dune crest, i.e. the distance the overwashing flow has to traverse before accelerating down the rear dune slope; however direct measurement of this was made difficult by the large variation in profile measurement techniques and measurement resolution. For example, the Hatteras and Assateague Island profiles were measured using Airborne Topographic Mapping (ATM) for which the vertical accuracy of individual point measurements is deemed to be +/-0.15 m (SALLENGER et al., 2003), and vertical fluctuations (assumed to be noise) in the vertical profiles of up to 0.25 m was observed. Other profiles had as few as three data points to represent a dune. To allow an easy comparison between highly varying profiles, $B_D$, was defined as the width 0.3 m below the beach crest.

A representative dune volume, $V_D$, was calculated according to

$$V_D = \frac{1}{2} D^2 (s_f + s_r) \qquad (1)$$

This dune volume, per unit dune length, approximates the relative amount of material available in the dune for overwash. This value is zero where dunes do not exist.

The hydrodynamic parameters used are the significant deepwater wave height, $H_0$, the peak wave period corresponding to that height, $T$, surge level (including tide), $S$, and overwash duration, $t_s$. Run-up heights, $R$, were calculated after WISE et al., (1996), using $H_0$, $T$ and $s_{ave}$, where $R$ is the run-up excursion if the slope, $s_{ave}$, extends indefinitely (Figure 2(a)).

One aspect to consider when defining such parameters is that they are reasonably easy to estimate with some confidence, for either a hindcasting or forecasting situation. The most difficult aspect of finding suitable parameter values is the time variation that often occurs in these values. The maximum wave height, $H_{max}$, and the corresponding wave period, $T_{max}$, for the same time-step were chosen as the simplest representative values. Similarly, the maximum water level over the measurement period, $S_{max}$, was chosen to represent the storm surge including tide, $S$. Choosing a mean value is difficult, as one also needs to define a time period over which this should be calculated. The use of maximum values also allows forecast peak return wave heights and periods to be used in a predictive mode.

The overwash duration, $t_s$, was defined as the period over which the initial barrier/dune crest, $Y_c$, was overtopped by the combined run-up height and water level, $R+S$. An additional parameter, $F$, taking into account both the magnitude and duration of overtopping, was calculated by integrating the excess run-up height, $R+S-Y_c$, over the overwash duration, $t_s$, according to JIMENEZ et al. (2007).

To test the predictive capacity of the non-dimensional parameters resulting from the analysis, two-dimensional plots of the non-dimensional parameter values for the data points were made, such that one parameter was represented on each axis. Each profile response category was assigned a different symbol and if there is some relation between the plotted parameters and the profile response, some regional separation of one or more of the response types will be seen. If the region can in some way be delineated, a criterion can be defined. The approach is similar to that described by KRAUS et al., (1991) for evaluation of beach erosion/accretion predictors. It was assumed for all profile response types that both the storm hydrodynamics and the pre-storm morphology play a role in determining the overall profile response. Hence, it was deemed important to include at least one hydrodynamic and one morphodynamic dimensional parameter in each plot.

# RESULTS

There was no single non-dimensional plot for which the differences between each profile response type were immediately obvious. Instead several criteria are required to differentiate the various cross-shore profile responses to overwash.

## Crest Accumulation

Crest accumulation is thought to be caused by the deposition of sediment from wave run-up as it decelerates up to and on the beach crest. Wave run-up imposed on surge level is therefore an important factor but the results of this study indicated that the variation in surge level is more important than the variation in wave run-up height. Figure 3 shows a non-dimensional plot of a relative surge height parameter vs. a relative dune width parameter. Each symbol represents a different profile response type. The surge height is presented as a percentage of the crest height, $S_{max}/Y_c$, and the dune width is non-dimensionalised using the width of the beach between the beach crest and MSL, $Y_c/s_{ave}$ which represents the horizontal distance travelled by the run-up. Some separation between the different response types is observed.

The crest accumulation points are clustered to the lower right-hand side of the other points, indicating that crest accumulation occurs primarily at low surge levels but that slightly higher surge levels can cause crest accumulation if the crest width is larger. Crest width, therefore, may be seen to restrict the more erosive overwash types. There must, however, be some threshold to this. For a large enough surge level, the crest width becomes irrelevant. This is indeed observed by the *barrier* response type points on the upper right side of the graph.

A similar non-dimensional plot can be made, interchanging $R_{max}/Y_c$ for $S_{max}/Y_c$. Figure 4 shows the effect of the maximum run-up height relative to the beach crest height. Note how the crest accumulation points are now scattered. The total water level, $S_{max} + R_{max}$, non-dimensionalised by $Y_c$, was also tested but also this resulted in large scatter of the crest accumulation and other points. This indicates that crest accumulation overwash only occurs for lower surge levels, but may occur for a wide range of run-up heights superimposed on these surge levels.

## Landward Translation of Dunes/Berms

Dune translation is the least intuitive of the overwash profile responses and the mechanisms responsible for this are not known. One hypothesis is that an erosive overwash regime first causes

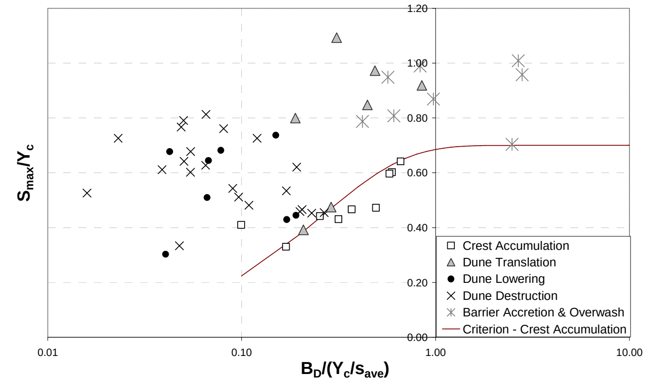


Figure 3. $S_{max}/Y_c$ vs. $B_D/(Y_c/s_{ave})$ – Crest Accumulation

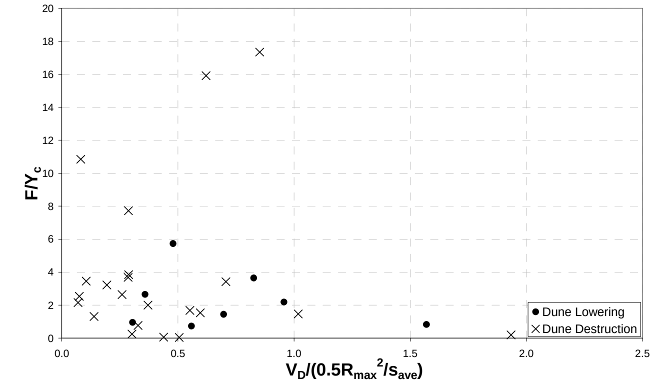


Figure 5. $F/Y_c$ vs. $V_D/(0.5R_{max}^2/s_{ave})$ – Dune Responses

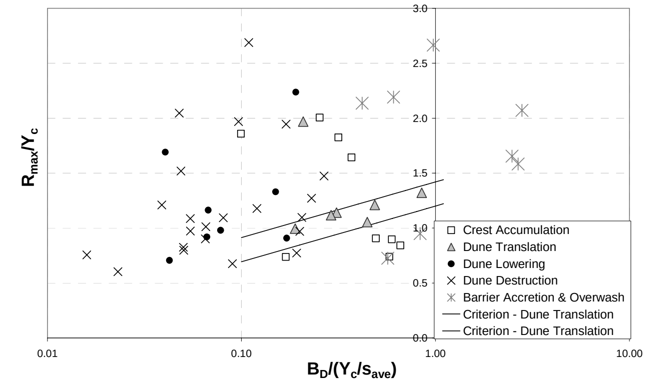


Figure 4. $R_{max}/Y_c$ vs. $B_D/(Y_c/s_{ave})$ – Dune Translation

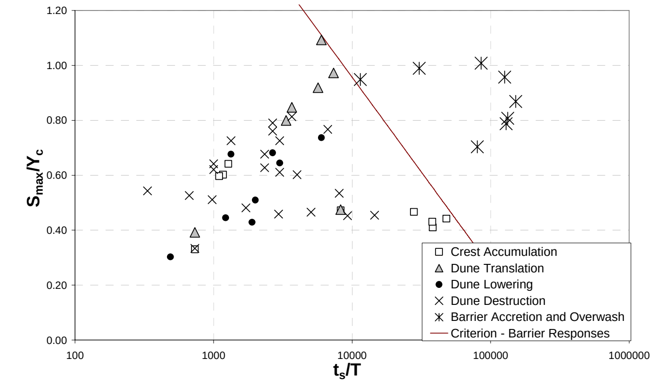


Figure 6. $S_{max}/Y_c$ vs $t_s/T$ – Barrier Accretion and Overwash

dune lowering, followed by a period of accumulation overwash restoring the dune to its original height translated landward. Such a hypothesis could not be verified by representative storm hydrodynamics parameters; however, some clustering of the dune translation points for different parameter sets was observed. Figure 4 shows a clustering of the dune translation data points for large relative crest widths and low relative run-up levels. Contrary to the results observed for crest accumulation, Figure 3 indicates that landward translation may occur for a wide range of surge levels. It may therefore be concluded that landward translation of dunes/berms occurs for a small range in run-up heights superimposed on a wider range of surge levels.

## Dune Lowering and Dune Destruction

On Figures 3 and 4, clustering of the dune lowering and dune destruction points may also be observed (note the logarithmic scale). These two responses are clustered together under a threshold surge level and for low relative dune widths, but may occur for a wider range of run-up heights. No trend may be seen separating the two data sets, so another parameter set is required to separate dune lowering from dune destruction.

Parameters representing the storm duration, $t_s$ or $F$ were expected to be the most important parameters to distinguish the two responses but relatively poor separation was observed for either parameter. Dune volume, $V_D$, was shown to be the most useful parameter. This was non-dimensionalised by the profile volume above SWL which is traversed by the run-up for a hypothetical constant slope profile. This quantity was suggested by WISE et al., (1996) to take into account the subaerial profile volume and geometry when determining the landward limit of overwash for a simple overwash algorithm in SBEACH, a numerical model for simulating storm-induced cross-shore beach change. Figure 5 shows a plot of $V_D/(0.5R^2/s_{ave})$ vs. $F/Y_c$. There is no clear separation of the dune lowering and dune destruction points but the dune lowering points are clustered towards the right half of the dune destruction points, giving some indication that dunes with larger volumes are less readily destroyed. Surprisingly, $F$ has little discernible effect. Several different sets of dimensional and non-dimensional parameters were tested to improve the separation between the two response types, but none was found.

## Barrier Responses

On Figures 3 and 4, it can be seen that the barrier responses are typically represented by higher surge levels (as a percentage of beach crest height) and wider beach crest widths but may occur for a large range of relative run-up heights. Typically the barrier response will be observed on a barrier if a dune is not present, hence the wider beach crest widths. Further parameters, however, are required to separate these points from the other responses. For example, barriers without dunes may also undergo the crest accumulation type response.

Barrier responses were expected to occur for high surge and run-up levels, low crest heights, and long storm durations. Figures 3 and 4, however, already indicate that variation in surge level is of more importance than variation in run-up height. A non-dimensional parameter representing the number of waves overtopping the original crest height, $N = t_s / T_{max}$ was plotted against $S_{max}/Y_c$, shown in Figure 6. The barrier response points appear on the upper right side of the plot and for some barrier response points $N$ is up to an order of magnitude larger than the other categories, so a logarithmic x-scale is used, showing good separation between barrier response and other points.

## DISCUSSION

Crest accumulation is caused by the deposition of sediment on the beach crest by decelerating run-up overwash as it overtops the beach crest. It was previously thought that crest accumulation was limited by a threshold $R+S$, such that either a large surge with small run-up heights or small surge with larger run-up heights would cause the response, as long as the run-up height on top of the surge only slightly exceeded the beach crest. The results, however, show that crest accumulation only occurs at lower surge levels and once a threshold run-up height is exceeded, the magnitude of the run-up height superimposed on this surge level is less important. A similar finding was made by Leatherman (1976) by correlating accretion volume measured during a field experiment with the surge level and wave height. Much stronger correlations were found for surge level than for wave height.

One possible explanation is that large wave heights do not necessarily lead to large run-up heights during overwash at low surge levels. Infiltration into the dune would be much larger at lower surge levels, as would deceleration due to friction, because the water table is lower and the distance travelled by the swash is larger. High infiltration rates and deceleration due to friction reduce the run-up extent.

A wider beach or dune crest allows accumulation overwash to occur at higher surge levels because the flow would decelerate due to friction and infiltration on a wide flat crest, but this is limited by a threshold surge level of approximately 45% of the beach crest height. If the surge level exceeds this, the more erosive overwash responses will occur.

The mechanism causing the landward translation of an intact dune or berm is still not entirely understood, however, the results of this parametric study indicate that it occurs primarily for dunes with wider crests, or multiple dune systems, and for low run-up levels relative to the beach crest height. Lower run-up levels are thought to indicate lower overwash volumes (DONNELLY et al., 2006), but they may also indicate smaller landward penetration of overwash. It is proposed that the wider dune crest lowers at a slower rate than a narrow dune crest because the quantity of sediment to be transported from the dune is less. The sediment from the wider dune may also be deposited nearer to the original dune crest (than in the case of dune lowering) due to the lower run-up levels and because some deceleration may occur along the crest top. In regions with multiple dunes, the sediment is deposited nearer to the original dune crest because flow deceleration occurs as the overtopping flow reaches the rear dune. The sediment deposited behind the foredune may cause a feedback mechanism whereby flow decelerates at the new deposit, causing more sediment to be deposited. On the waning stages of the storm, the surge level decreases and crest accumulation overwash transports sediment from what is left of the original dune (which may eventually act as a bar), depositing it on the new dune crest.

The results for dune lowering and dune destruction indicated that both these responses occur primarily on narrower dunes and typically, dunes of lower initial volume are more readily destroyed. It is thought that run-up overwash flow erodes sediment from the beach crest and rear dune slope and deposits sediment as it decelerates on the back barrier slope due to the combined effects of lateral spreading, friction and infiltration. Contrary to expectation, larger $t_s$ or $F$ values did not cause dune destruction. This is probably because the simple definition of overtopping relative to the initial beach crest produces similar overtopping duration parameters, $t_s$ or $F$, for both dune lowering and dune destruction. If a dune with less volume is ultimately destroyed, it is most likely lowering at a faster rate and more overtopping occurs at the lowered crest elevations. This positive feedback mechanism cannot be taken into account in a simple parametric comparison. It is therefore still difficult to predict if a dune will be lowered or completely destroyed during an overwash event using this method.

The *barrier* response types include barrier accretion, barrier rollover and barrier disintegration. As the name suggests, this response is mainly (but not always) limited to barrier islands and spits without dunes and the pre-storm morphology was therefore an important factor. The response was typically seen to occur on profiles with low pre-storm crest heights and low foreshore slopes. Hydrodynamics, particularly the surge level and storm duration however, also played a part. For example, at lower surge levels crest accretion was observed on some barrier profiles. At higher surge levels, sediment is deposited landward of the crest on the back barrier slope causing barrier accretion. Eventually a threshold to distinguish the barrier responses from the other responses was described using $N$, the number of waves overtopping the original crest height and $S_{max} / Y_c$, the surge level as a percentage of the crest height above MSL.

Sufficient data was not available to study the differences between barrier accretion, barrier rollover and barrier disintegration but it is proposed that barrier rollover occurs for higher surge and run-up levels than barrier accretion because larger flow velocities are required to transport sediment into the back barrier bay. The barrier width at sea level must therefore also play a role, as might the bay water level. It is also proposed that barrier disintegration occurs for even higher surge and run-up levels but barrier disintegration may also occur instead of barrier rollover where the subaqueous beach slope on the bay side of the profile is steep, such that transported sediments are deposited in deep water. Again, the bay water level also must play a part.

The proliferation of ATM (LIDAR) surveys along the United States Gulf and Atlantic coasts where overwash occurs frequently will improve both the temporal and spatial resolution of overwash data sets. To date, very few pre- and post-storm data sets extend to the back barrier bay shoreline. As such data become available, the barrier width and back barrier slopes may also be taken into account to distinguish profile responses. This method might also be further developed by taking into account the longshore variation in the storm hydrodynamics, in particular the profile distance from the storm centre and the tide gauge. Local variations in surge level and shoaled wave height, for example, could be extracted from circulation and wave transformation models if the bathymetric and boundary conditions are known. Wind, vegetation and human development on barriers also affect the type of overwash response. Finally, it is acknowledged that two or more of the responses may occur under the one storm.

### Recommendations

Using the best set of parameters to distinguish each profile change type, some criteria to predict cross-shore beach profile change due to overwash, from readily available data sets, were derived.

To predict crest accumulation, an exponential curve was fitted between the crest accumulation data points and the rest of the data points on Figure 3. The exponential curve was chosen such that a threshold surge level at which accumulation does not occur, regardless of dune width, is reached. The criterion for prediction of crest accumulation is therefore defined by:

$$\frac{S_{\max}}{Y_c} \leq m_1 \left(1 - e^{-\alpha_1 \frac{B_D}{Y_c / s_{ave}}}\right) \qquad (2)$$

where the coefficients $m_1$ and $\alpha_1$ where determined to be 0.7,

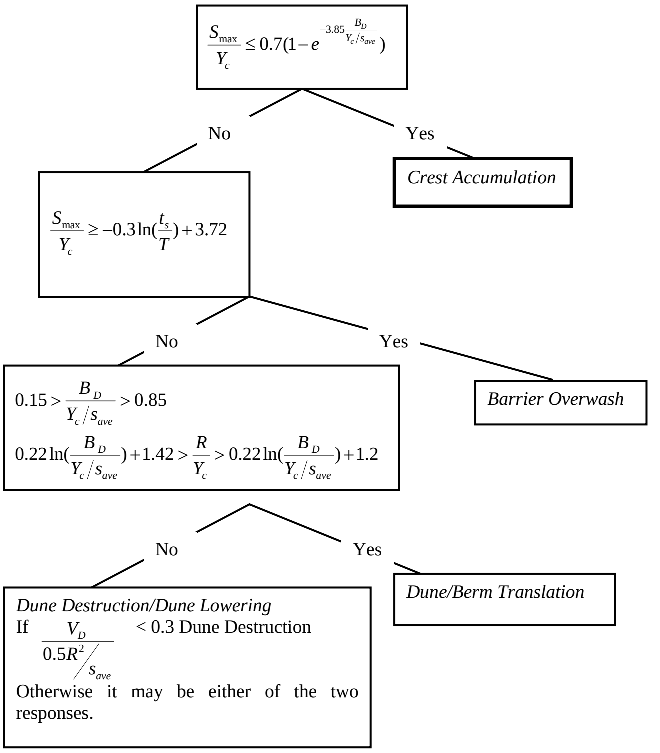

Figure 7. Flow chart guide for predicting response type

and 3.85 respectively. This criterion represents the threshold between accretion and erosion of the beach crest.

The barrier island responses may be predicted using a simple logarithmic equation. This type of function was chosen to represent that at either very high surge levels or very long storm durations, barrier overwash will occur. The criterion for prediction of barrier overwash is defined by:

$$\frac{S_{max}}{Y_c} \geq a_2 \ln(\frac{t_s}{T}) + m_2 \quad (3)$$

where the coefficients $m_2$ and $\alpha_2$ were determined to be 3.72 and -0.3 respectively. This criterion is plotted on Figure 6.

Defining criteria for the other responses was less obvious and until they can be tested with more data or until more is known about the driving mechanisms, only simple linear criteria will be proposed. Figure 7 is a flow chart outlining how one can predict the type of profile response expected for a particular storm using a pre-storm profile and the outlined hydrodynamic data. It should be noted that the prediction criteria for landward translation of dune/berms and to separate dune lowering from dune destruction require further development and are only included as a rough guideline. Testing the predictions with more data sets would also help develop the robustness of the method. Predicting whether or not overwash will occur was outside the scope of this study but should be added to the criteria for completeness.

## CONCLUSIONS

Non-dimensionless parameters taking into account pre-storm morphology and storm hydrodynamics were used to develop a simple method to qualitatively predict the type of cross-shore morphologic change following an overwash event, and to develop an understanding of overwash mechanisms. The results showed that accumulation overwash is controlled by surge level and beach crest width, and barrier overwash is controlled by surge level and storm duration. Dune translation and dune lowering occur for narrower dunes. The two responses could not be separated by storm duration as expected; however, there is some indication that larger dune volumes limit the occurrence of dune destruction. Storm duration is still believed to be of importance but could not be estimated to a sufficient degree of accuracy using the simple methods defined. The results also indicated to some extent that dune translation is limited to a small range of run-up heights and dune widths. Using these results, some simple criteria to predict the type of cross-shore response to overwash using readily available data were suggested.

## LITERATURE CITED

BYRNES, M. R. and GINGERICH, K. J., 1987. Cross-island profile response to Hurricane Gloria. *Proceedings Coastal Sediments '87* (New Orleans, Louisiana, ASCE), pp. 1486-1502.

DONNELLY, C.; RANASINGHE, R. and LARSON, M. 2006. Numerical modelling of beach profile change caused by overwash, *Proceedings Coastal Dynamics '05* (Barcelona, Spain, CD-ROM, ASCE), 14 pp.

DONNELLY, C.; WAMSLEY, T.V.; KRAUS, N.C.; LARSON, M., AND HANSON, H. 2007. Morphologic classification of coastal overwash. *Proceedings of the 30th Conference of Coastal Engineering* (San Diego, California, ASCE), in press.

EISER, W. C., and BIRKEMEIER, M., 1991. Beach profile response to Hurricane Hugo. *Proceedings Coastal Sediments '91* (Seattle, Washington, ASCE), pp. 1681-1696.

JIMENEZ, J.A.; SALLENGER, A.H., and FAUVER, L. 2007. Sediment transport and barrier island changes during massive overwash events. *Proceedings of the 30th Conference of Coastal Engineering* (San Diego, California, ASCE), in press.

KRAUS, N.C.; LARSON, M., and KRIEBEL, D.L. 1991. Evaluation of beach erosion and accretion predictors. *Proceedings Coastal Sediments '91* (Seattle, Washington, ASCE), pp. 572-587.

LEATHERMAN, S.P. 1976. Barrier island dynamics: overwash processes and eolian transport. *Proceedings of the 15th Coastal Engineering Conference* (Honolulu, Hawaii, ASCE), pp. 1959-1974.

MATIAS, A.; VILA-CONCEJO, A.; FERREIRA, Ó. and DIAS, J.A. 2003. Field measurements of morphologic variations during an overwash event. *Thalassas, Special issue for the 4th Symposium on the Iberian Continental Margin,* 19 (2b), pp. 164-165.

MORTON, R.A. 2002. Factors controlling storm impacts on coastal barriers and beaches - a preliminary basis for near real-time forecasting. *Journal of Coastal Research,* 18(3), 486-501

MORTON, R. A., AND SALLENGER , A. H., JR. 2003. Morphological impacts of extreme storms on sandy beaches and barriers. *Journal of Coastal Research* 19(3), 560-573.

PRICE, W.A. 1947. Equilibrium of form and forces in tidal basins of coast of Texas and Louisiana, *Bulletin of the American Association of Petroleum Geologists,* 31 (9), 1619-1663.

SALLENGER, A.H.; KRABILL, W.B.; SWIFT, R.N.; BROCK, J.; LIST, J.; HANSEN, M.; HOLMAN, R.A.; MANIZADE, S.; SONTAG, J.; MEREDITH, A.; MORGAN, K.; YUNKEL, J.K.; FREDERICK, E.B. and STOCKDON, H. 2003. Evaluation of airborne topographic lidar for quantifying beach changes. *Journal of Coastal Research,* 19 (1), 125-133.

STONE, G.W.; LIU, B.; PEPPER, D.A.; and WANG, P. 2004. The importance of extratropical and tropical cyclones on the short-term evolution of barrier islands along the northern Gulf of Mexico, USA. *Marine Geology* 210, 63-78.

WISE, R.A.; SMITH, S. J., and LARSON, M., 1996. SBEACH: Numerical model for simulating storm-induced beach change. Report 4, cross-shore transport under random waves and model validation with Supertank and field data. Technical Report CERC-89-9, U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center, Vicksburg, MS. 140pp.

## ACKNOWLEDGEMENTS

The study was partly conducted as an activity of the Coastal Morphology Modelling and Management (Cascade) work unit of the System-Wide Water Resources Program (SWWRP) and partly as part of the European Commission research project FLOODsite (Contract Number: GOCE-CT-2004-505420).

Sincere thanks are expressed to the many people who supplied me with interesting data and helpful insights into the data. They are: Mark Byrnes (Applied Coastal Research and Engineering, Inc.); William Eiser (South Carolina Department of Health and Environmental Control); Randy Wise (U.S. Army Corps of Engineers, Philadelphia District); Abby Sallenger and staff of the U.S. Geological Survey, St Petersburg; staff at Coastal Planning and Engineering, Inc.; Robert Neal (Lee County Division of Natural Resources, FL), Christopher Bender (Taylor Engineering); Mark Leadon and Gary Cook (Florida Bureau of Beaches and Shores); and Ana Matias (CIACOMAR, Universidade do Algarve, Portugal). Constructive reviews and advice provided by Magnus Larson is also greatly appreciated.