Identifying Sub-environments in a Tidal Flat – A Multidimensional Scaling Approach

[1]Ankur Roy, [2]Tapan Mukerji & Amitabha Chakrabarti

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Supplementary Materials

Research Summary

Ripple Index alone is not enough for distinguishing between tidal channels and estuarine setting

Grain-size parameters Mean, Sorting, Skewness and Kurtosis are considered

Cross plotting grain-size parameters help to some extent → "ambiguity" even in color coded cross-plots

Dissimilarity Matrix between samples constructed from RI and grain-size parameters → a "distance" measured between samples and plotted → City-Block and Standard Euclidean distances give good "separation"

Can we Identify paleo-environments from rock record ?

Acknowledgments

*Current & former PhD / MSc students of the **Reservoir Research Initiative (RRI) Group**, IIT Kharagpur: Ajay Sahu, Ketan Kumar & Rayaan Biswas.*
Dr. Asoke Deysarkar, PfP Industries, Houston, TX, for his continuous support & encouragement

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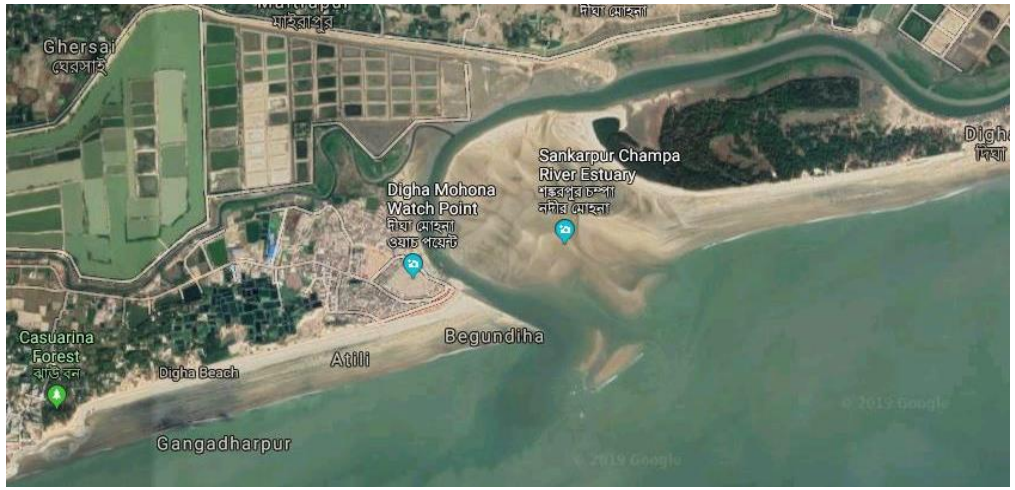
Supplementary Materials: Field Areas of Digha & Chandipur

Estuarine area in Digha (INDIA)



Chandipur (INDIA): Tidal Channel

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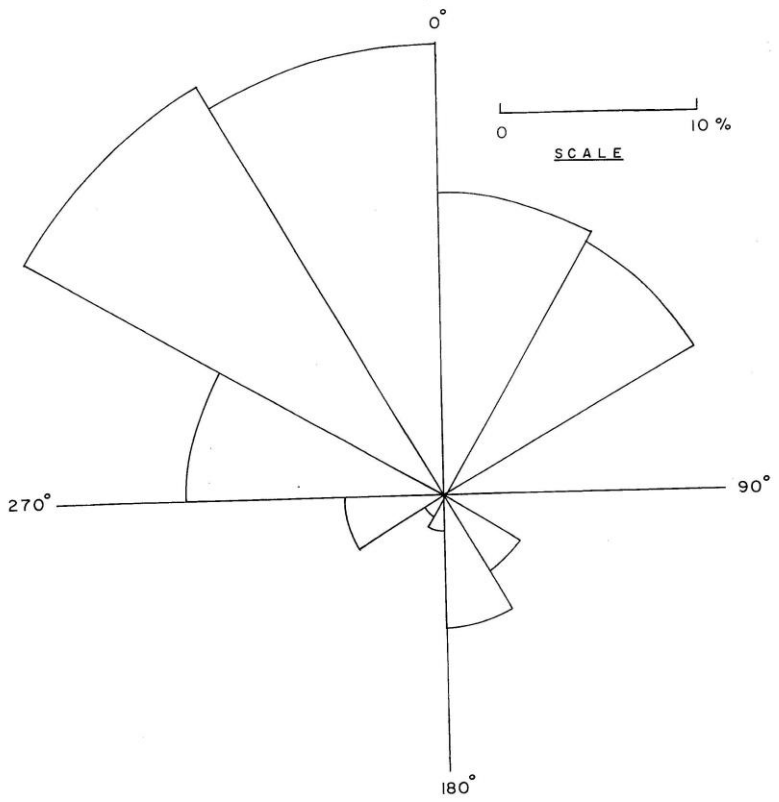
Supplementary Materials: Field Photos & Rose Diagrams showing current directions

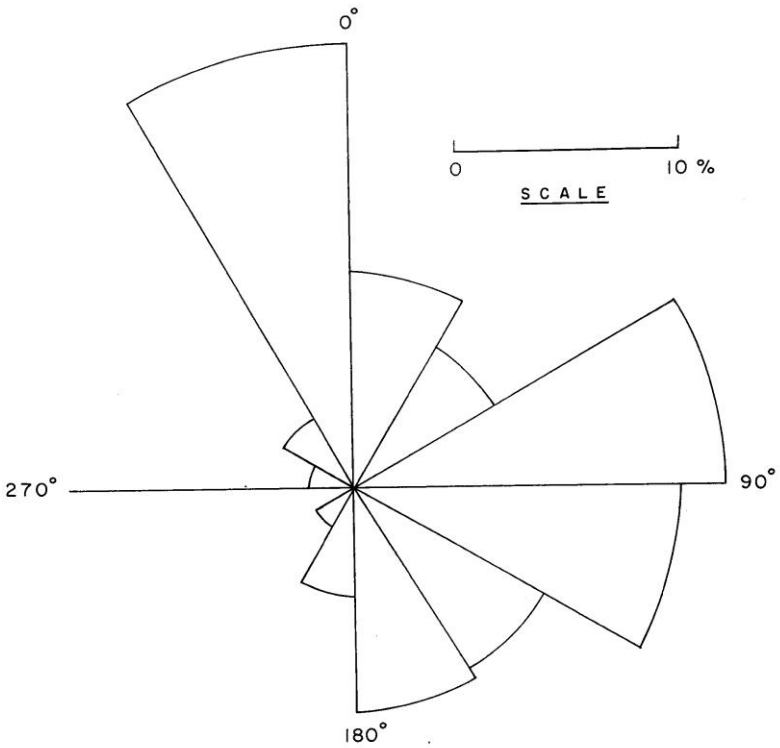
Ripple Marks (estuarine region)

Ripple Marks

Current Direction: CHANDIPUR



DIGHA



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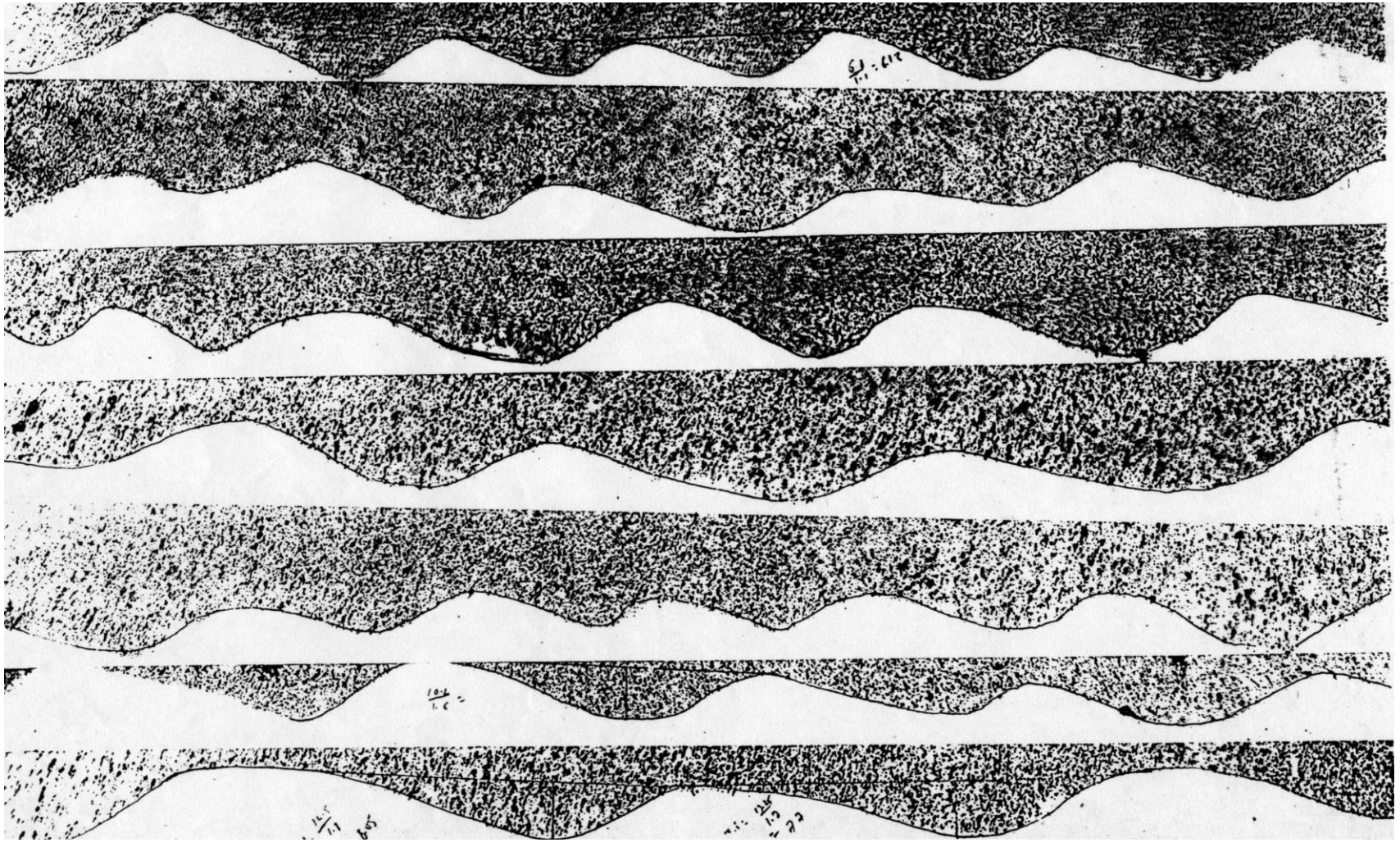
Supplementary Materials: Ripple Profile from Estuary



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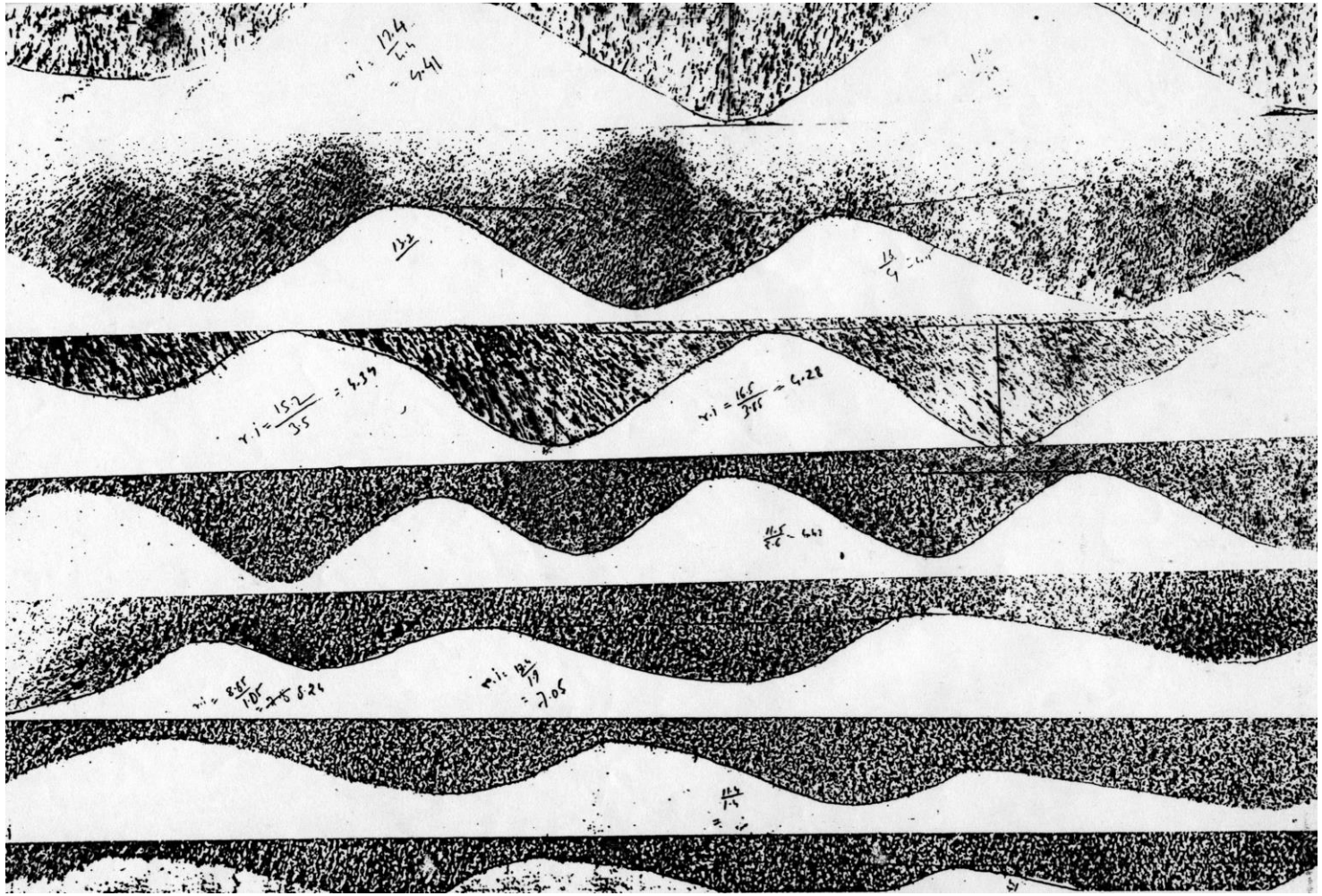
Supplementary Materials: Ripple Profiles from Tidal Channel



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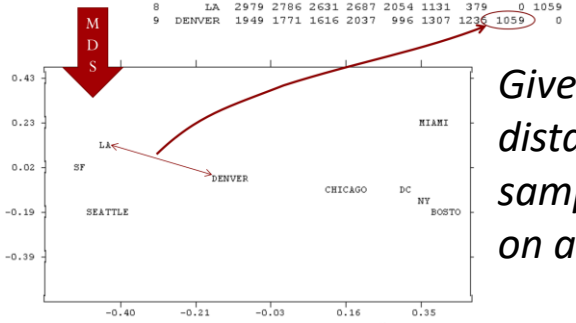
Supplementary Materials: The MDS Concept

If pairwise distances between N = 9 cities available → uniquely map them on a 2D map

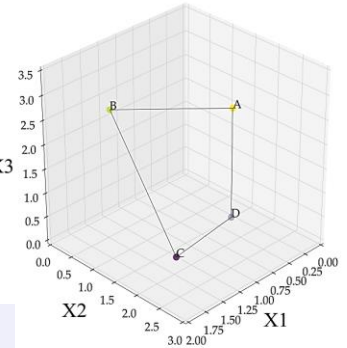
	1 BOST	2 NY	3 DC	4 MIAM	5 CHIC	6 SEAT	7 SF	8 LA	9 DENV
1 BOSTON	0	206	429	1504	963	2976	3095	2979	1949
2 NY	206	0	233	1308	802	2815	2934	2786	1771
3 DC	429	233	0	1075	671	2684	2799	2631	1616
4 MIAMI	1504	1308	1075	0	1329	3273	3053	2687	2037
5 CHICAGO	963	802	671	1329	0	2013	2142	2054	996
6 SEATTLE	2976	2815	2684	3273	2013	0	808	1131	1307
7 SF	3095	2934	2799	3053	2142	808	0	379	1235
8 LA	2979	2786	2631	2687	2054	1131	379	0	1059
9 DENVER	1949	1771	1616	2037	996	1307	1235	1059	0



Given pairwise distances between N samples → map them on any dim ≤ N

Picture Courtesy: Jef Caers

MDS embeds samples in a lower dimension space with pairwise distances as close as possible to the input distance matrix.



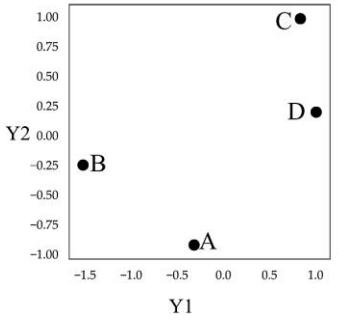


figure: Mancell & Deutsch, 2019

Euclidean Distance in Original Space (3-dimensions)				
A	B	C	D	Entity
	1.69	2.53	2.20	A
		2.66	2.61	B
			0.82	C
				D

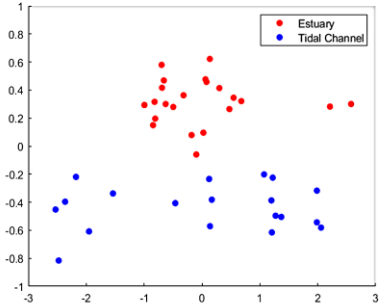
Euclidean Distance in Lower Dimension (2-dimensions)				
A	B	C	D	Entity
	1.71	2.53	2.20	A
		2.67	2.59	B
			0.82	C
				D

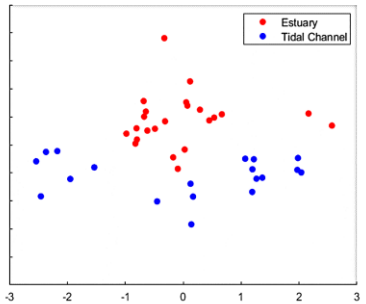
MDS Plots using Different Distances

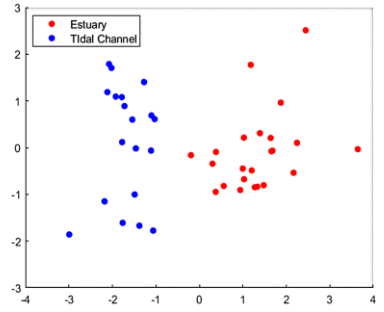
Sample No.	MEAN (M_Z)	KURTOSIS(K_G)	SORTING(σ_I)	SKEWNESS (Sk_I)	RIPPLE INDEX(RI)
1	3.2	1	0.468	0.055	7.42
2	3.1	1.35	0.683	-0.222	7.33
-	-	-	-	-	-
42	3.27	1.028	0.502	0.196	5.88

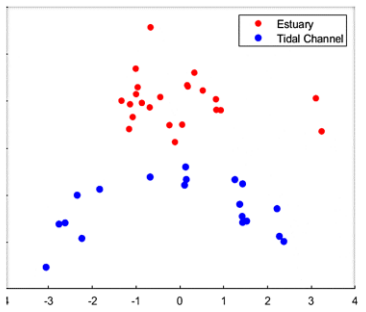
Euclidean $d(x,y) = \sqrt{\sum_{i=1}^{n}(x_i - y_i)^2}$

Minkowski $p = 3$ $\left(\sum_{i=1}^{n}|x_i - y_i|^p\right)^{1/p}$









Standard Euclidean

City-Block $d = \sum_{i=1}^{n} |x_i - y_i|$

42 ripple samples, each with values of mean, sorting, skewness and ripple-index → distance matrix formulated from the table above. Four different distances used Euclidean, Standard Euclidean, City-Block and Minkowski

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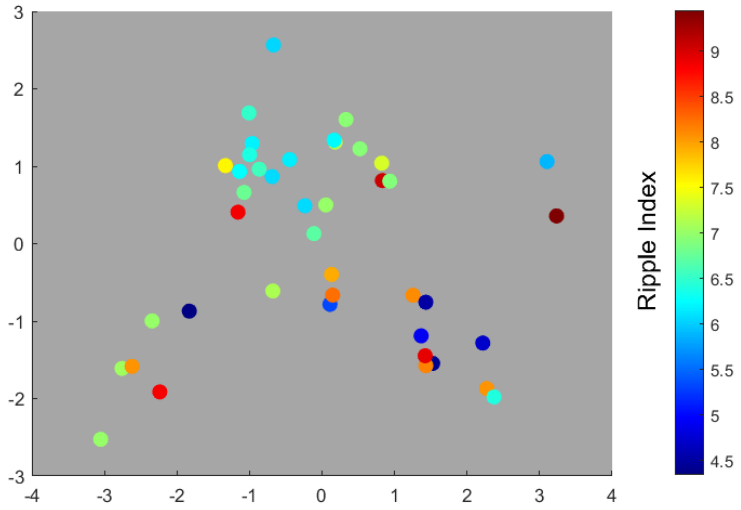
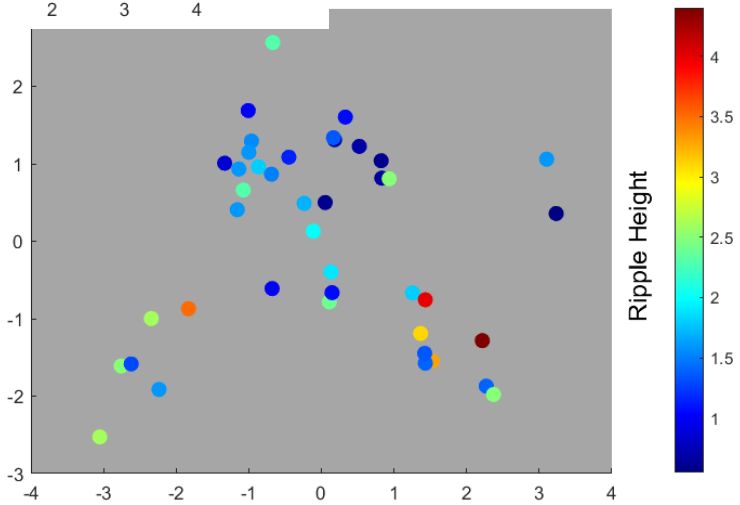
Supplementary Materials: MDS Plots colored with Ripple Index & Ripple Height

MDS Plots: City Block Distance





MDS Plots: Standard Euclidean Distance