

Seeing Through the Eye of the Storm Using the - Lens of Nature

How Nature-based Solutions Enhance Resiliency and Provide Value

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What Lens Are You Looking Through?

Conventional



Photo by Andy Holmes on Unsplash

Nature-Based



Photo by Jeff Finley on Unsplash



Agenda

- What Does a Conventional Approach Look Like When It Fails?
- ***** How Do You Assess Climate to be Proactive?
- What Does a Nature-based Plan Look Like?



Frequency and Cost of Disasters Continue to Rise



What Does a Conventional Approach Look Like When It Fails?

Superfund Site infrastructure impacted with extreme weather events





Impacts to the Site







Ground Water Treatment Pumping & Conveyance Stormwater Management Water Supply Power Security & Access



Extensive Rebuild with Resilience





Building Resilience into Beneficial Reuse

Create wetlands and upland meadow habitat

- Provide for active/passive recreation
- Partial diversion of stream to reduce flow into downstream river during flood events







How Do You Assess Climate to be Proactive?

Incorporating Climate Science, Business Strategy, and Resilience Engineering for a Proactive Solution





Analysis and Access of Global Portfolio Risk Data





Global Portfolio Climate Change Risk Assessment - Relative Risk Data Interface

Company: Acme Corp. | Project: 0123456.00 | Version: 2022-05-11

Figure 1 - Site Locations and Relative Climate Risk Category (hover over site for details)



Relative Climate Risk Cat. 1 - Low

Data Table 1 - Relative Climate Risk Ranking and Analysis

Total Relative Risk Score	Risk Cat.	1st Max	2nd Max	D	F	н	Ρ	W	C	R
4.94	3 - High	С	W	0.95	0.81	0.84	0.37	0.97	0.99	0.00
4.65	3 - High	F	W	0.87	0.98	0.95	0.87	0.98	0.00	0.00
4.21	3 - High	R	н	0.13	0.88	0.93	0.78	0.51	0.00	0.99
4.14	3 - High	W	н	0.72	0.85	0.86	0.79	0.92	0.00	0.00
4.05	3 - High	F	н	0.40	0.99	0.97	0.89	0.80	0.00	0.00
3.92	3 - High	н	P	0.48	0.75	0.96	0.86	0.86	0.00	0.00
3.89	3 - High	С	D	0.87	0.18	0.67	0.40	0.78	0.99	0.00
3.84	3 - High	W	D	0.84	0.83	0.77	0.50	0.90	0.00	0.00
3.83	3 - High	C	н	0.34	0.02	0.95	0.85	0.66	1.00	0.00
3.81	3 - High	Н	F	0.24	0,94	0.99	0.81	0.84	0.00	0.00
3.72	3 - High	F	н	0.53	0.95	0.86	0.67	0.71	0.00	0.00
3.71	3 - High	R	н	0.25	0.32	0.90	0.82	0.43	0.00	1.00
	Total Relative Risk Score 4.94 4.65 4.21 4.14 4.05 3.92 3.89 3.84 3.83 3.81 3.72 3.71	Total Relative Risk Score 4.94 3 - High 4.65 3 - High 4.21 3 - High 4.21 3 - High 4.14 3 - High 3.92 3 - High 3.89 3 - High 3.84 3 - High 3.83 3 - High 3.81 3 - High 3.71 3 - High	Total Relative Risk Score Risk Cat. Tst Max 4.94 3 - High C 4.94 3 - High F 4.94 3 - High F 4.95 3 - High R 4.14 3 - High W 4.05 3 - High F 3.92 3 - High F 3.89 3 - High C 3.84 3 - High C 3.83 3 - High C 3.81 3 - High F 3.71 3 - High R	Total Relative Risk ScoreRisk Cat.Tst Max2nd Max4.943 - HighCW4.653 - HighFW4.213 - HighRH4.143 - HighWH4.053 - HighFH3.923 - HighFH3.893 - HighCD3.843 - HighWD3.833 - HighCH3.813 - HighHF3.723 - HighHF3.713 - HighRH	Total Relative Risk Score Risk Cat. 1st Max 2nd Max D 4.94 3 - High C W 0.95 4.65 3 - High F W 0.87 4.21 3 - High R H 0.13 4.14 3 - High W H 0.72 4.05 3 - High F H 0.40 3.92 3 - High F H 0.40 3.92 3 - High F D 0.87 3.84 3 - High C D 0.87 3.84 3 - High W D 0.84 3.83 3 - High K D 0.84 3.81 3 - High H F 0.24 3.72 3 - High F H 0.53 3.71 3 - High R H 0.25	Total Relative Risk Score Risk Cat. 1st Max 2nd Max D F 4.94 3 - High C W 0.95 0.81 4.65 3 - High F W 0.87 0.98 4.21 3 - High R H 0.13 0.88 4.14 3 - High W H 0.72 0.85 4.05 3 - High F H 0.40 0.99 3.92 3 - High F H 0.40 0.99 3.92 3 - High C D 0.87 0.18 3.89 3 - High C D 0.87 0.18 3.84 3 - High W D 0.84 0.83 3.83 3 - High K D 0.84 0.83 3.83 3 - High H F 0.24 0.94 3.72 3 - High F H 0.53 0.95 3.71 3 - High R	Total Relative Risk Score Risk Cat. 1st Max 2nd Max D F H 4.94 3 - High C W 0.95 0.81 0.84 4.65 3 - High F W 0.87 0.98 0.95 4.21 3 - High R H 0.13 0.88 0.93 4.14 3 - High W H 0.72 0.85 0.86 4.05 3 - High F H 0.40 0.99 0.97 3.92 3 - High F H 0.40 0.99 0.97 3.92 3 - High H P 0.48 0.75 0.96 3.89 3 - High C D 0.87 0.18 0.67 3.84 3 - High W D 0.84 0.83 0.77 3.83 3 - High K H 0.34 0.02 0.95 3.81 3 - High H F 0.24 0.94	Total Relative Risk Score Risk Cat. 1st Max 2nd Max D F H P 4.94 3 - High C W 0.95 0.81 0.84 0.37 4.65 3 - High F W 0.87 0.98 0.95 0.87 4.21 3 - High R H 0.13 0.88 0.93 0.78 4.14 3 - High W H 0.72 0.85 0.86 0.79 4.05 3 - High F H 0.40 0.99 0.97 0.89 3.92 3 - High F H 0.40 0.99 0.97 0.80 3.89 3 - High H P 0.48 0.75 0.96 0.86 3.84 3 - High W D 0.87 0.18 0.67 0.40 3.83 3 - High C D 0.84 0.83 0.77 0.50 3.83 3 - High C H <td>Total Relative Risk Score Risk Cat. 1st Max 2nd Max D F H P W 4.94 3 - High C W 0.95 0.81 0.84 0.37 0.97 4.65 3 - High F W 0.87 0.98 0.95 0.81 0.84 0.37 0.98 4.21 3 - High F W 0.87 0.98 0.95 0.87 0.98 4.14 3 - High R H 0.13 0.88 0.93 0.78 0.51 4.14 3 - High F H 0.40 0.99 0.97 0.89 0.80 3.92 3 - High F H 0.40 0.99 0.97 0.89 0.80 3.92 3 - High F D 0.87 0.18 0.67 0.40 0.78 3.83 3 - High K D 0.84 0.83 0.77 0.50 0.90 3.83 3 -</td> <td>Total Relative Risk Score Risk Cat. 1st Max 2nd Max D F H P W C 4.94 3 - High C W 0.95 0.81 0.84 0.37 0.97 0.99 4.65 3 - High F W 0.87 0.98 0.95 0.81 0.84 0.37 0.97 0.99 4.21 3 - High F W 0.87 0.98 0.95 0.87 0.98 0.00 4.14 3 - High R H 0.13 0.88 0.93 0.78 0.51 0.00 4.05 3 - High F H 0.40 0.99 0.97 0.89 0.00 3.92 3 - High F H 0.40 0.99 0.97 0.89 0.80 0.00 3.89 3 - High C D 0.87 0.18 0.67 0.40 0.78 0.99 3.84 3 - High C H 0.3</td>	Total Relative Risk Score Risk Cat. 1st Max 2nd Max D F H P W 4.94 3 - High C W 0.95 0.81 0.84 0.37 0.97 4.65 3 - High F W 0.87 0.98 0.95 0.81 0.84 0.37 0.98 4.21 3 - High F W 0.87 0.98 0.95 0.87 0.98 4.14 3 - High R H 0.13 0.88 0.93 0.78 0.51 4.14 3 - High F H 0.40 0.99 0.97 0.89 0.80 3.92 3 - High F H 0.40 0.99 0.97 0.89 0.80 3.92 3 - High F D 0.87 0.18 0.67 0.40 0.78 3.83 3 - High K D 0.84 0.83 0.77 0.50 0.90 3.83 3 -	Total Relative Risk Score Risk Cat. 1st Max 2nd Max D F H P W C 4.94 3 - High C W 0.95 0.81 0.84 0.37 0.97 0.99 4.65 3 - High F W 0.87 0.98 0.95 0.81 0.84 0.37 0.97 0.99 4.21 3 - High F W 0.87 0.98 0.95 0.87 0.98 0.00 4.14 3 - High R H 0.13 0.88 0.93 0.78 0.51 0.00 4.05 3 - High F H 0.40 0.99 0.97 0.89 0.00 3.92 3 - High F H 0.40 0.99 0.97 0.89 0.80 0.00 3.89 3 - High C D 0.87 0.18 0.67 0.40 0.78 0.99 3.84 3 - High C H 0.3

Company Data Filters Figure 2 - Relative Climate Change Risk Category **Climate Risk Data Filters** Breakdown of Sites Climate Period 80 SBU 2020-2039 All 4 2040-2059 60 2060-2079 2080-2099 40 Facility Type **Relative Climate Risk** 20 AIL Category 1 - Low 0 2 - Med 2 - Med 3 - High 1 - LOW Region 🗌 3 - High 2.41 All 4 Avg. Total Relative Risk Score of Sites 193 Max 2nd Max # of Sites Selected Stressor Stressor Figure 3 - Climate Change Stressor Contribution of Sites Country D C W DD F F D AIL \sim F III H H P W P **Facility Name** R W O Search A Select all Reset All Filters to Default **Climate Change Stressor Legend** 0.50 0.50 D = Drought H F = Flooding Potential H = Extreme Heat P = Extreme Seasonal Precipitation W = Wildfire Conditions C = Coastal Inundation 0.37 V R = Riverine Inundation 0.49 Woodard & Curran Contact Information: msjones@woodardcurran.com



Summary of Total Relative Risk Scores and Stressor Percent Ranks

Timeframe	2020	2020-2039									2040-2059							2060-2079								2080-2099								
name	D	F	Н	Ρ	W	С	R	TRRS	LMH	D	F	н	Ρ	W	С	R	TRRS	LMH	D	F	н	Ρ	W	С	R	TRRS	LMH	D	F	н	Ρ	W	С	R
Abu Dhabi	0.84	0.57	0.78	0.26	0.84	0.00	0.00	3.29	3 - High	0.78	0.48	0.63	0,28	0.64	0.00	0.00	2.80	2 - Med	0.52	0.55	0.48	0,25	0.34	0.00	0.00	2.14	1 - Low	0.54	0.59	0.47	0.31	0.38	0.00	0,0
Abuja	0.53	0.65	0.78	0.91	0.46	0.00	0.00	3.33	3 - High	0.41	0.97	0.77	0.88	0,44	0.00	0.00	3.47	3 - High	0.33	0.35	0.75	0.89	0.46	0.00	0.00	2.78	2 - Med	0.31	0.70	0.80	0.85	0.55	0.00	0.0
Accra	0.40	0.99	0.97	0.89	0.80	0.00	0.00	4.05	3 - High	0.39	0.80	0.95	0.82	0.87	0.00	0.00	3.82	3 - High	0.40	0.96	0.95	0.80	0.88	0.00	0.00	3,99	3 - High	0.41	0.73	0.95	0.17	0.88	0.00	0.0
Addis Ababa	0.21	0.45	0.00	0.50	0.11	0.00	0.00	1.27	1 - Low	0.38	0,81	0.00	0.71	0.20	0.00	0.00	2.10	1 - Low	0.33	0.77	0.01	0.75	0.16	0.00	0.00	2.02	1 - Low	0.26	0.63	0.02	0.79	0.11	0.00	0.0
Algiers	0.97	0.78	0.71	0.17	0.93	0.00	0.00	3.57	3 - High	0.97	0.43	0.63	0.37	0.90	0.00	0.00	3.29	3 - High	0.95	0.25	0.58	0.29	0.81	0.00	0.96	3.84	3 - High	0.93	0.22	0.53	0.25	0.72	0.00	0.9
Amman	1.00	0.27	0.58	0.20	0.96	0.00	0.00	3.02	2 - Med	1.00	0.26	0.54	0.28	0.95	0.00	0.00	3.04	2 - Med	0.99	0.13	0.51	0.19	0.86	0.00	0.00	2.69	2 - Med	1.00	0.17	0.51	0.27	0.79	0.00	0.0
Amsterdam	0.37	0.34	0.00	0.67	0.40	0.00	0.00	1.77	1 - Low	0.36	0.51	0.00	0.62	0.31	0.00	0.00	1.80	1 - Low	0.42	0.39	0.01	0.63	0.21	0.00	0.00	1.66	1 - Low	0.45	0.35	0.24	0.69	0.19	0.00	0.0
Andorra la Vella	0.84	0.51	0.00	0.62	0.73	0.00	0.00	2.71	2 - Med	0.87	0.53	0.00	0.23	0,67	0.00	0.00	2.30	2 - Med	0.97	0.42	0.30	0.33	0.78	0.00	0.00	2.81	2 - Med	0.93	0.31	0.33	0.44	0.67	0.00	0.0
Ankara	0.84	0.60	0.00	0.33	0.73	0.00	0.00	2.51	2 - Med	0.85	0.29	0.00	0.65	0.65	0.00	0.00	2.43	2 - Med	0.86	0.47	0.01	0.49	0.66	0.00	0.00	2.47	2 - Med	0.90	0.37	0.02	0.47	0,64	0.00	0.0
Antananarivo	0.55	0.11	0.00	0.74	0.38	0.00	0.00	1.78	1 - Low	0.60	0.77	0.00	0.48	0.43	0.00	0.00	2.28	2 - Med	0.54	0.85	0.01	0.43	0.32	0.00	0.00	2.14	1 - Low	0.51	0.62	0.02	0.45	0.28	0.00	0,0
Apia	0.19	0.24	0.98	0.98	0.85	0.00	0.00	3.24	3 - High	0.21	0.78	0.96	0.48	0.99	0.00	0.00	3.43	3 - High	0.18	0.71	0.92	0.40	0.92	0.00	0.00	3.13	3 - High	0.24	0.35	0.93	0.02	0.97	0.00	0.0
Ashgabat	0.93	0.39	0.56	0.20	0.87	0.00	0.00	2.95	2 - Med	0.94	0.24	0.55	0.35	0.78	0.00	0.00	2.86	2 - Med	0.93	0.34	0.50	0.25	0.75	0.00	0.00	2.77	2 - Med	0.90	0.17	0.49	0.34	0.68	0.00	0.0
Asmara	0.40	0.12	0.00	0.24	0.24	0.00	0.00	1.00	1 - Low	0.51	0.55	0.00	0.26	0.33	0.00	0.00	1.65	1 - Low	0.56	0.23	0.01	0.31	0.35	0.00	0.00	1.45	1 - Low	0.52	0.65	0.27	0.38	0.32	0.00	0.0
1	~ ~ · ·	0.77.6	1.00	0.54	10.00		0.66	2.2.4	- 19 - 18 A - 1	A. 4 4		0.00		-	11.76.76	0.00	1.05	3.0		6.64		10.54	10.41	0.00	0.00	a 11.00	- e); - ()	1.00	A = A		0.00			

Prioritize Resiliency Plan through Refined Climate Risk Assessments





Community Level



Site Level



Asset Level



What Does a Nature-based Plan Look Like?



Remedy Drivers



Historic Mining



Stormwater Treatment Sediment Capture



Public Engagement



Conventional Design



Concrete Channel

ESG Goals Misaligned

Not in Public Interest

Long-term Solution



GROVE CREEK

Resilient Design

Bio-Remediation Basin

On

OUTLET STRUCTURE

1000

Resilient Design Details



- Treatment flow design for 6-month RI
- Maximum orifice flow 20 cfs
- Allows for maximum sediment removal
- Weir overflow accommodate larger storms







Plant Selection for Phyto-remediation

WETLAND PLANTINGS IN-

LOWER BENCH OF CHANNEL

UPLAND PLANTING



Fuzzy Tongue Penstemon (Zn)



Yarrow (Cd)



Cattail (As)



90TH PERCENTILE FLOW

8-MONTH STORM HIGH WATER LEVEL = 5:448.75 (1.06

ACRE-FEET VOLUME

 ∇

Showy Milkweed



BASEFLOW

5' MIN. WIDTH BOTTOM

Marsh marigold



UPLAND BENCI WIDTH VARIES

LINE PILOT CHANNEL WITH WETLAND PLANTINGS PER LANDSCAPE PLANS NPARIAN

Horn tail



Looking through the nature-based lens

	Nature-based	Conventional
CAPEX		•
Flexible Storm Design	•	1
Community aesthetic value	2	-
Enhance Biodiversity	2	14
Recharge local groundwater	<u>.</u>	
Retention time	•	
OPEX	*>	*5
End of Life	•	1
Carbon Footprint	•	4







Nature-based Solutions - Feel Good!

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