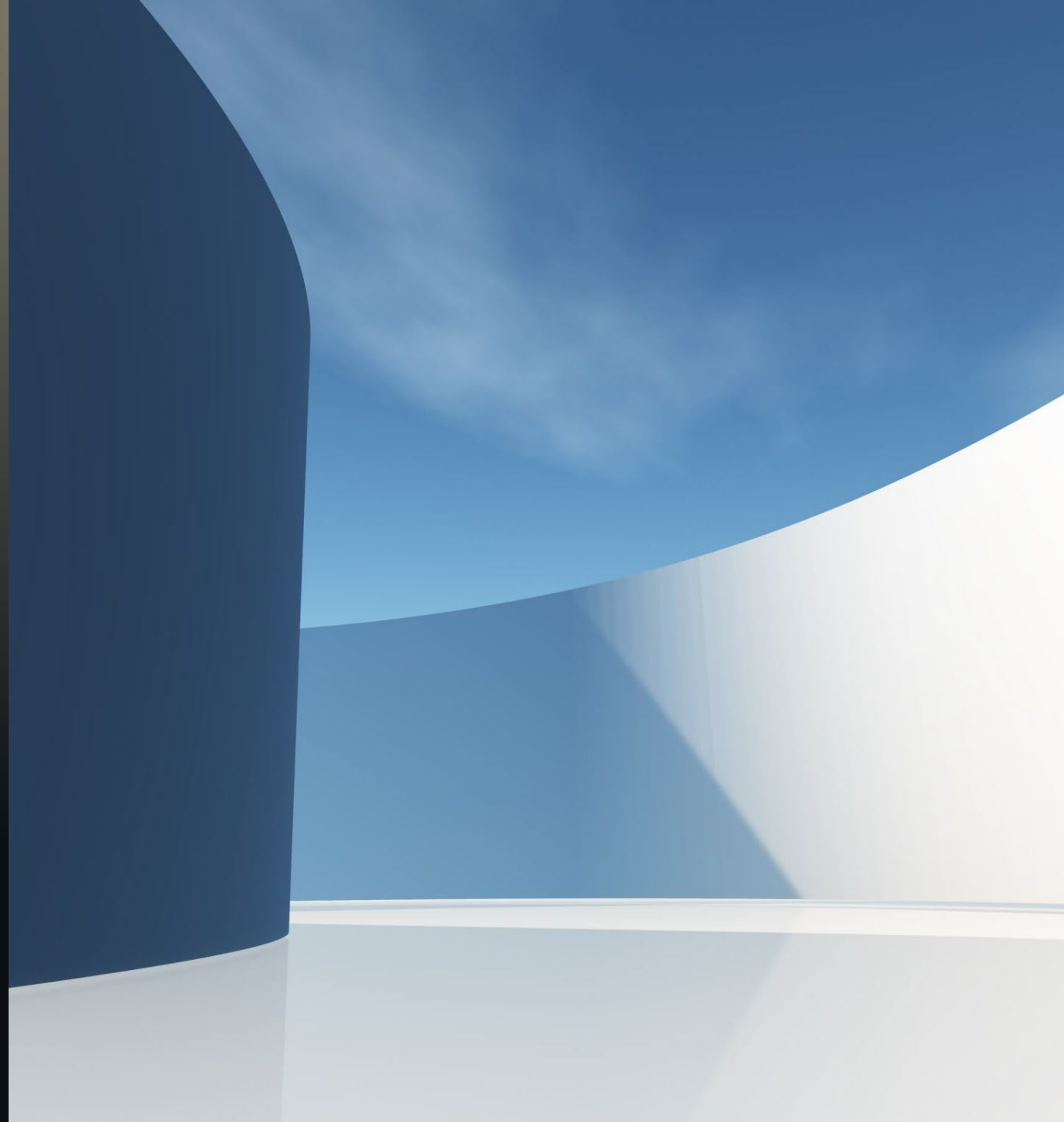
Oregon EJ Mapping Tool Decision Points

BACKGROUND INFORMATION



Decision Points: Why are they important?

Composite indices are complex and there are many options for the EJ Council to choose from that will determine how the Oregon EJ Mapping Tool is structured and how the information is displayed.

HB 4077, sections 10-12 include language that will help guide the EJ Council through the decision-making process, but the content leaves a lot of room for flexibility.

All environmental justice mapping tools get evaluated, critiqued, and scrutinized. Therefore, it is important to have a rationale that supports each decision made in the development of the Oregon EJ Mapping Tool.

DECISION POINTS 1-10

- #1 • Indicator domain selection
- #2 • Geographic units (tracts, grids, etc.)
- #3 • Geographic designations • Geographic comparisons
- #4 • Domain/indicator weighting
- #5 • Domain aggregation (multiplicative, additive, etc.)
- #6 • Data standardization (percentiles, z-scores, other)
- #7 • Indicator selection - community listening session priorities and data gaps
- #8 • Sensitivity analysis results - revisit indicator selection and data gaps
- #9 • EJ community thresholds/flags
- #10 • EJ mapping tool visualizations & reporting

Weighting Methods

ENVIRONMENTAL JUSTICE MAPPING
DECISION POINT 4

AUGUST 7, 2024 RECORDING LINK

OCTOBER 10, 2024 RECORDING LINK

DECISION POINT #4 – WEIGHTING METHODS

- No weighting – CDC Environmental Justice Index/Environmental Justice Screening Method
- Subdomain weighting – CalEnviroScreen/Washington Environmental Health Disparities Map/Colorado EnviroScreen
- Regression domain weighting – California Healthy Places Index
- Principal component analysis – EPA Environmental Quality Index
- Participatory methods – technical experts + community preference surveys + statistics

DECISION POINT #4 – Method Evaluation

Build a working dataset for Oregon Census tracts

- Select Indicators from the U.S. Climate Vulnerability Index
- Categorize indicators by subdomain – environmental exposures, environmental hazards, climate change risks, built environment, human health, social factors
- Standardize raw indicator values as percentiles
- Analyze weighting methods
- Compare results – tracts in the 80th percentile by community designation

DECISION POINT #4

Equal Weighting Method - CDC Environmental Justice Index

Environmental Exposures + **Environmental Hazards** + **Climate Change Risks** + **Built Environment** + **Human Health** + **Social Factors**

- All indicators and domains are weighted equally.
- Domains are only weighted the same if they have an equal number of indicators.

"Due to a lack of scientific evidence supporting a specific weighting scheme, all modules are weighted equally in calculating the Overall EJI Score."

DECISION POINT #4

Equal Weighting Method - Considerations

- The weighting method is easy to explain.
- The only way to balance domain weighting is by including an equal number of indicators in each domain.
- We will have no rationale for weighting indicators independently.
- Stategic indicator selection will be required to assure community concerns are prioritized.

DECISION POINT #4

Subdomain Weighting Method - Colorado EnviroScreen

PLACE
Environmental Exposures x 1.0
+
Environmental Hazards x 0.5
+
Climate Change Risks x 0.5
+
Built Environment x 0.5
÷ 2.5

X

PEOPLE
Human Health
+
Social Factors
÷ 2.0

DECISION POINT #4

Subdomain Weighting Method - Considerations

- The subdomain weighting method is slightly more difficult to explain than equal weighting.
- We do not currently have a rationale for weighting climate change risk and the built environment half as much as environmental exposures.
- As with equal weighting, we will not have a rationale for weighting indicators independently.
- Stategic indicator selection will be required to assure community concerns are prioritized.

DECISION POINT #4

Regression Weighting Method - California Healthy Places Index

Environmental Exposures x 5.0%	+	**Environmental Hazards x 5.0%**	+	**Climate Change Risks x 6.0%**	+	**Built Environment x 5.0%**	+	**Human Health x 43.0%**	+	**Social Factors x 36.0%**

- Domains are weighted by the strength of their relationship with life expectancy at birth.
- All domains are guaranteed a minimum of 5% weight.

DECISION POINT #4

Regression Weighting Method - Considerations

The Methodology Workgroup determined that a regression weighting method is not a good fit because:

- Life expectancy at birth has much stronger associations with human health and social factors than environmental indicators. Therefore, environmental concerns are undervalued in the model.

- The Oregon EJ Mapping Tool is directed to be an environmental justice tool, not a social determinants of health tool.

DECISION POINT #4

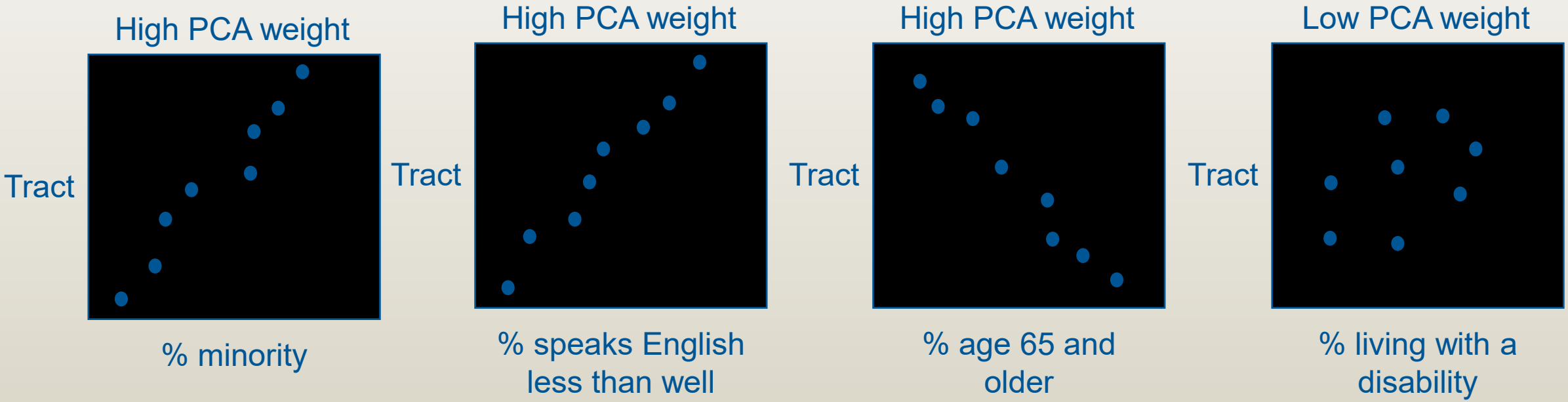
Principal Component Analysis – EPA Environmental Quality Index

Environmental Exposures x a%	+	Environmental Hazards x b%	+	Climate Change Risks x c%	+	Built Environment x d%	+	Human Health x e%	+	Social Factors x f%

- PCA is a technique used to simplify data and make it easier to analyze.
- Indicators are loaded into a variance matrix and the indicators are weighted based on their relationships with the other indicators inside the domain.
- Indicators with higher variation in their scores will receive higher weights. Indicators with lower variation in their scores will receive lower weights.

DECISION POINT #4

Principal Component Analysis Weighting



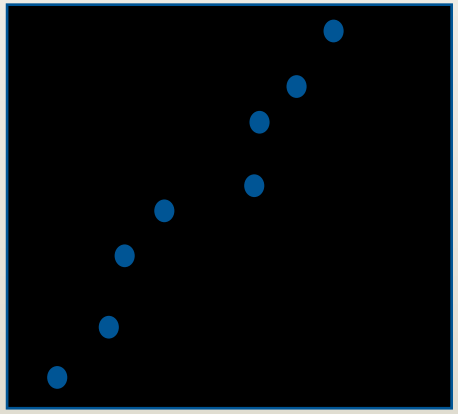
- There is a positive relationship between communities of color and people who speak English less than well with high variation in indicator scores.
- There is an inverse relationship with older populations, but similar variation in indicator scores.
- There is low variation in indicator scores for people living with a disability

DECISION POINT #4

Principal Component Analysis Weighting

High PCA weight

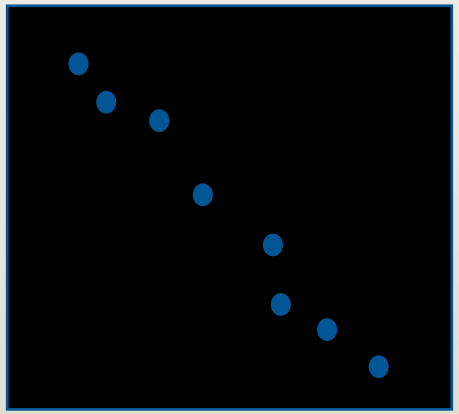
Tract



Annual ozone concentration

High PCA weight

Tract



Annual NO2 concentration

Tract X:
NO2 = 0.98
+
Ozone = 0.02
AQ index score = 0.5

- Tracts with high NO2 concentrations tend to have low ozone levels.
- Some inverse relationships can cause indicators to cancel each other out.
- This means we will need to be very strategic with indicator selection.

DECISION POINT #4

Principal Component Analysis Weighting Method - Considerations

Principal component analysis is complex and more difficult to explain than equal waiting and subdomain weighting.	Indicator weighting is determined by variance in the data, not impact on human health or quality of life. Stategic indicator selection will be required to assure community concerns are prioritized.	It is possible to develop a rationale for indicator weight adjustments.

DECISION POINT #4

Participatory Methods

Participatory methods incorporate input from various stakeholders like technical experts, citizens, and elected officials to help assign weights.

- Budget Allocation – a budget of N points is given to experts to allocate to a small number of indicators. Community surveys are helpful.
- Analytical Hierarchy Process - experts identify the problem to be solved, possible solutions, and the criteria used to judge the alternatives.
- Conjoint Analysis - survey-based statistical technique that incorporates the preferences of individuals (e.g., experts or the public).

DECISION POINT #4

Participatory Weighting Methods - Considerations

- Participatory methods can be used to combine community input with statistical analysis to create weighting schemes.
- Conjoint analysis is a good fit for developing community-driven indicator weighting because it relies heavily on community preference.
- Data collection for participatory weighting is time and labor-intensive requiring input from communities and technical experts.

DECISION POINT #4 – DOMAIN WEIGHTING

Introduction

Indicator weights represent the relative importance of each indicator as it contributes to the index.

If an index does not apply any weights explicitly, the indicators will be equally weighted. However, if some indicators or domains “matter” more than others, different weighting should be applied.

Whether choosing to keep equal weights or alter weights to favor indicators, the choice of weights is subjective and should be backed by a strong rationale.

DECISION POINT #4 – DOMAIN WEIGHTING

Why is weighting so complicated?

DECISION POINT #4 – DETERMINANTS OF HEALTH

Social and Environmental Determinants of Health

Image source: Whitehead, M. & Dahlgren, G. (1991). What can we do about inequalities in health? *The Lancet, 338*, 1059-1063.

What Accounts for Differences in Health?

- Genetics (5%)
- Personal Behaviors (30%)
- Quality of Health Care (10%)
- Social and Environmental Conditions (55%)

DECISION POINT #4 – CUMULATIVE RISK ASSESSMENT

Setting - Community
Pathway - Ambient Air
Exposure – Inhalation
Stressor – Nitrogen Dioxide
Exposure Time – 2 years
Exposure Concentration – 250 ppb

Short-Term Health Risks

- Eye irritation
- Coughing
- Wheezing

Long-Term Health Risks

- Reduced lung function
- Heart attack

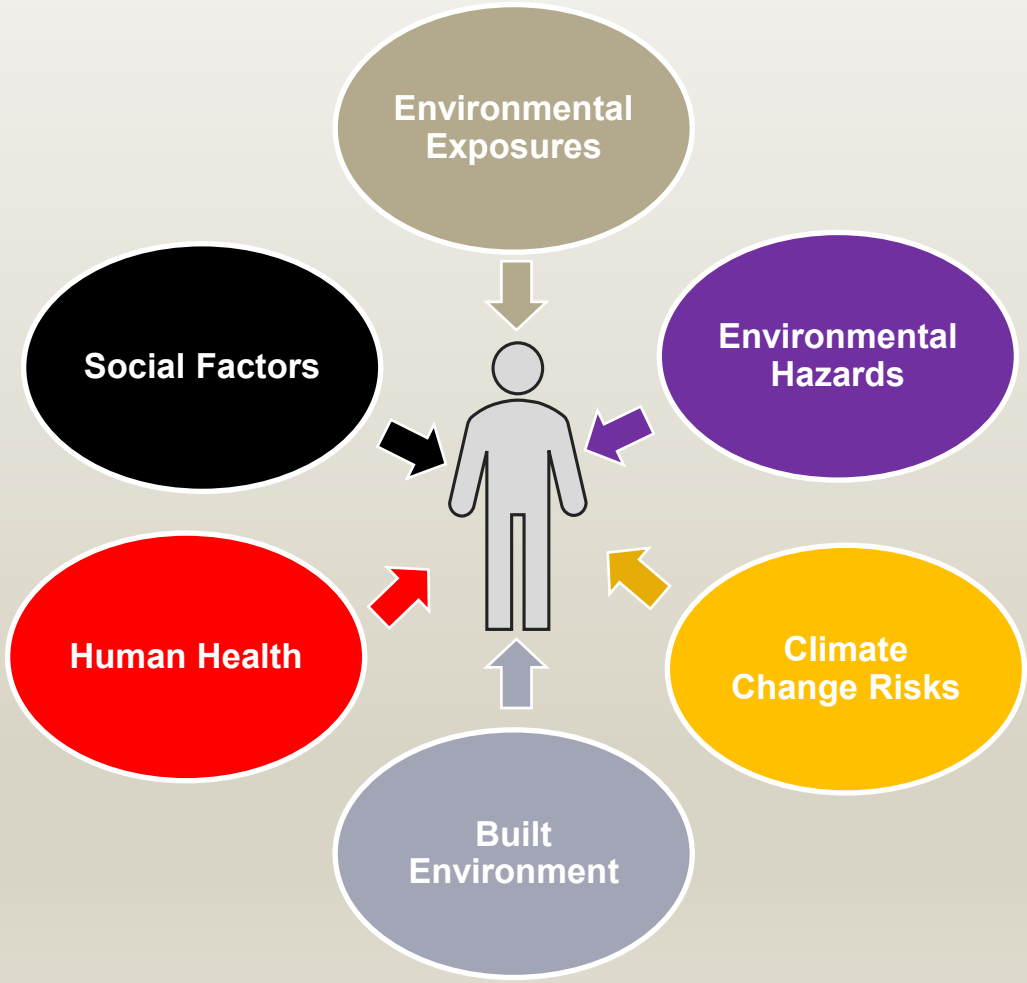
Stressors

- Age
- Sex
- Race/Ethnicity
- Economic status
- Individual behavior
- Pre-existing health conditions

Framework for Cumulative Risk Assessment. –EPA (May 2023)

DECISION POINT #4 – CUMULATIVE IMPACTS

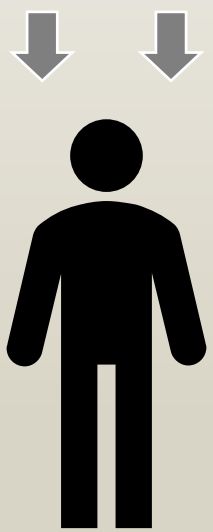
"The total harm to human health that occurs from the combination of environmental burden such as pollution and poor environmental conditions, pre-existing health conditions, and social factors such as access to quality healthcare."
-HHS (2022)



DECISION POINT #4 – CUMULATIVE IMPACTS

Community A

- Wildfire Risk
- Food Desert
- Limited Access to Healthcare



Community B

- Air Pollution
- Poor Water Quality
- Extreme Heat
- Language Barriers
- Historic Racism

- Excess Heart Disease

DECISION POINT #4 – WHAT WE KNOW

- Some of the environmental burdens listed in HB4077 affect human health and quality of life very differently. For example, environmental exposures impact communities differently than environmental hazards or climate change risks, although they can be related.

- Environmental burdens affect individual health unequally in ways that can be difficult to quantify.

- Some environmental burdens impact communities more inequitably than others.

- There are inverse relationships between some environmental burdens. For example, communities experiencing low PM2.5 concentrations can experience high ozone concentrations.

DECISION POINT #4 – WEIGHTING METHODS

NO WEIGHTING – ALL WEIGHTS AND DOMAINS ARE WEIGHTED THE SAME FACILITATING EASY INTERPRETATION OF THE INDEX BY A RANGE OF END-USERS.

CALENVIROSCREEN WEIGHTING – ENVIRONMENTAL HAZARD AND CLIMATE VULNERABILITY DOMAINS ARE WEIGHTED HALF AS MUCH AS ENVIRONMENTAL EXPOSURES BECAUSE THE POPULATION MAY NOT BE DIRECTLY OR REGULARLY EXPOSED TO HAZARDS AND CLIMATE CHANGE RISKS. HUMAN HEALTH AND SOCIAL FACTORS ARE WEIGHTED EQUALLY.

PRINCIPAL COMPONENT ANALYSIS – INDICATOR WEIGHTS ARE DETERMINED BY VARIANCE IN THE DATA AND INFLUENCE OF EACH INDICATOR ON THE SUBDOMAIN. DOMAINS ARE AGGREGATED AFTER INDICATORS ARE WEIGHTED.

CONJOINT ANALYSIS – COMMUNITY PREFERENCE SURVEYS + TECHNICAL EXPERT INPUT.

DECISION POINT #4 – METHOD EVALUATION

Equal Weighting Method - CDC Environmental Justice Index

Environmental Exposures + **Environmental Hazards** + **Climate Change Risks** + **Built Environment** + **Human Health** + **Social Factors**

- All indicators and domains are weighted equally.
- For example, if a domain has 6 indicators, each indicator will receive a weight of 16.67% (100/6).
- Domains are only weighted the same if they have an equal number of indicators.

"Due to a lack of scientific evidence supporting a specific weighting scheme, all modules are weighted equally in calculating the Overall EJI Score." ~CDC/ATSDR, 2022

DECISION POINT #4 – METHOD EVALUATION

Subdomain Weighting Method - Colorado EnviroScreen

PLACE
Environmental Exposures x 1.0
+
Environmental Hazards x 0.5
+
Climate Change Risks x 0.5
+
Built Environment x 0.5
÷ 2.5

X

PEOPLE
Human Health x 1.0
+
Social Factors x 1.0
÷ 2.0

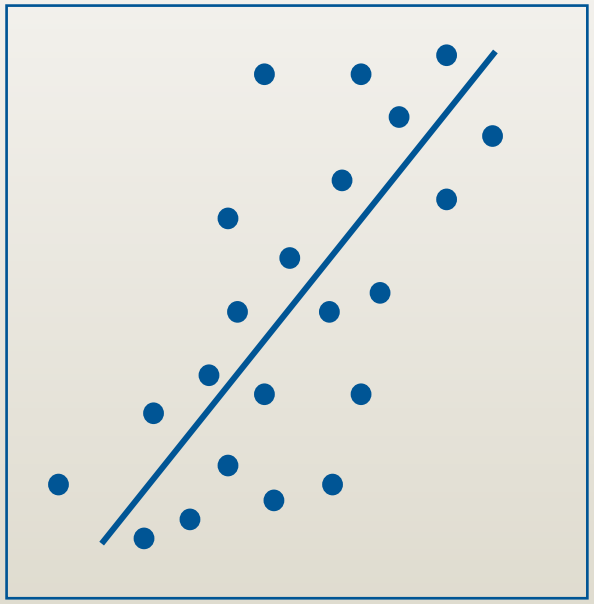
DECISION POINT #4 – METHOD EVALUATION

Principal Component Analysis – EPA Environmental Quality Index

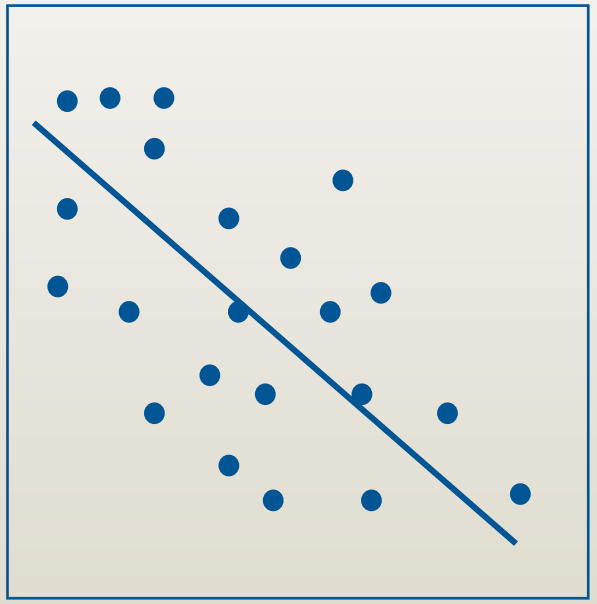
Environmental Exposures x a%	+	**Environmental Hazards x b%**	+	**Climate Change Risks x c%**	+	**Built Environment x d%**		**Human Health x e%**	+	**Social Factors x f%**

- In PCA individual indicators are weighted instead of the domains. The indicator weights then influence the domain weights.
- PCA measures the covariance between indicator scores. In other words, PCA measures the magnitude of inequities that exist between communities for selected indicators.
- Indicators are loaded into a covariance matrix and weighted based on their variance compared to other indicators.

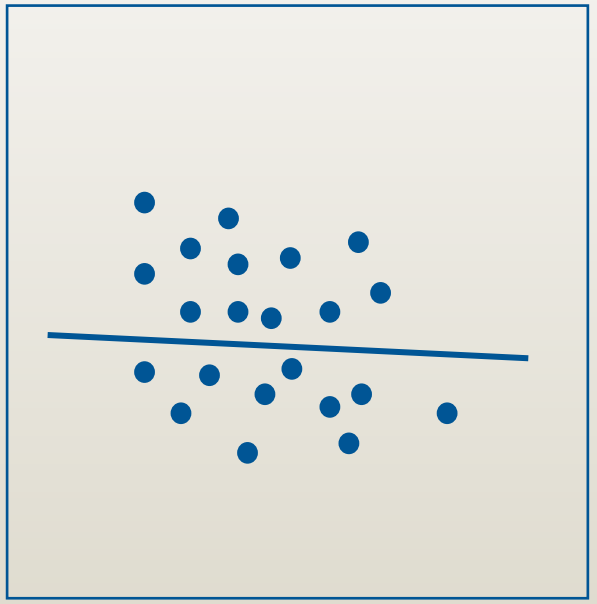
DECISION POINT #4 – METHOD EVALUATION



High positive covariance
(Household income)



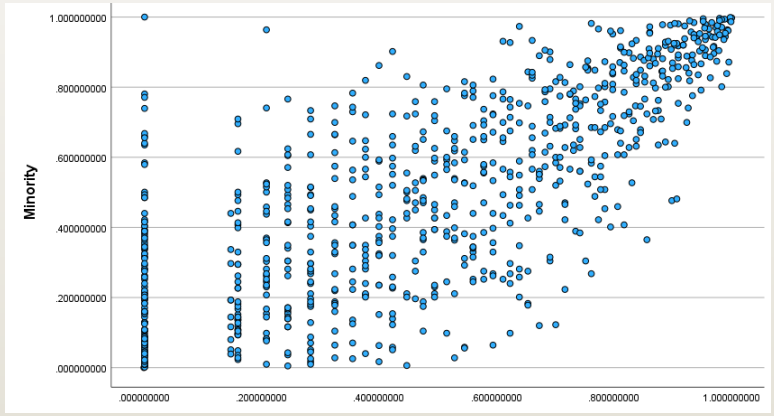
High negative covariance
(People 65 and older)



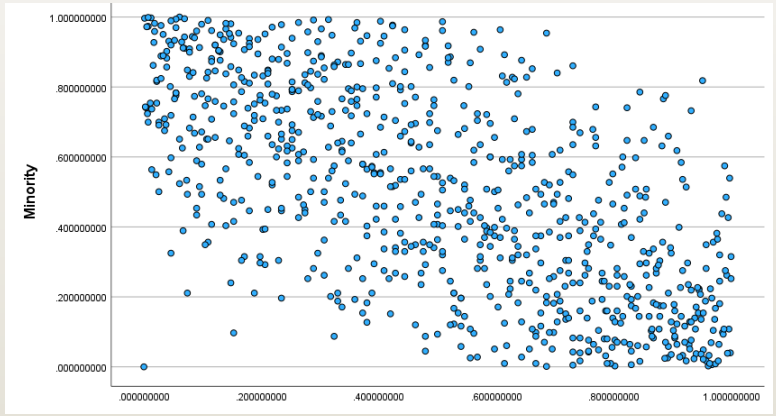
Low negative covariance
(Percent unemployed)

- Indicators with higher variation (inequities) will receive higher weights. Indicators with lower variation in their scores will receive lower weights.

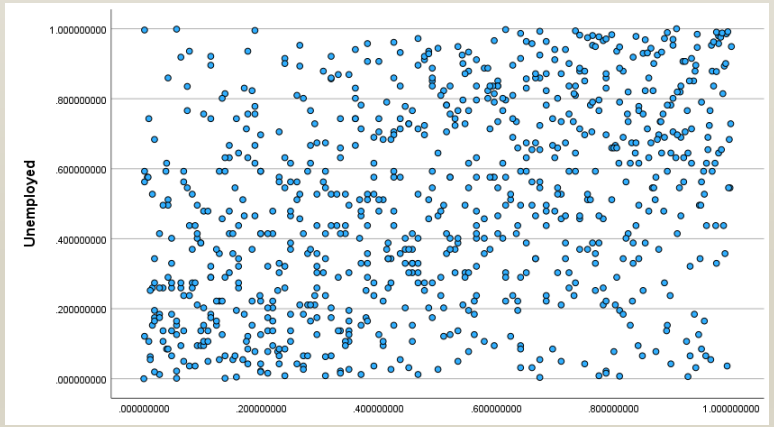
DECISION POINT #4 – METHOD EVALUATION



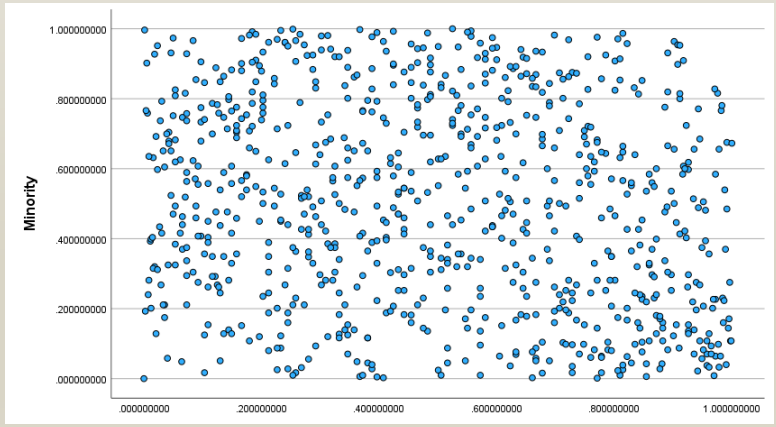
High positive covariance



High negative covariance

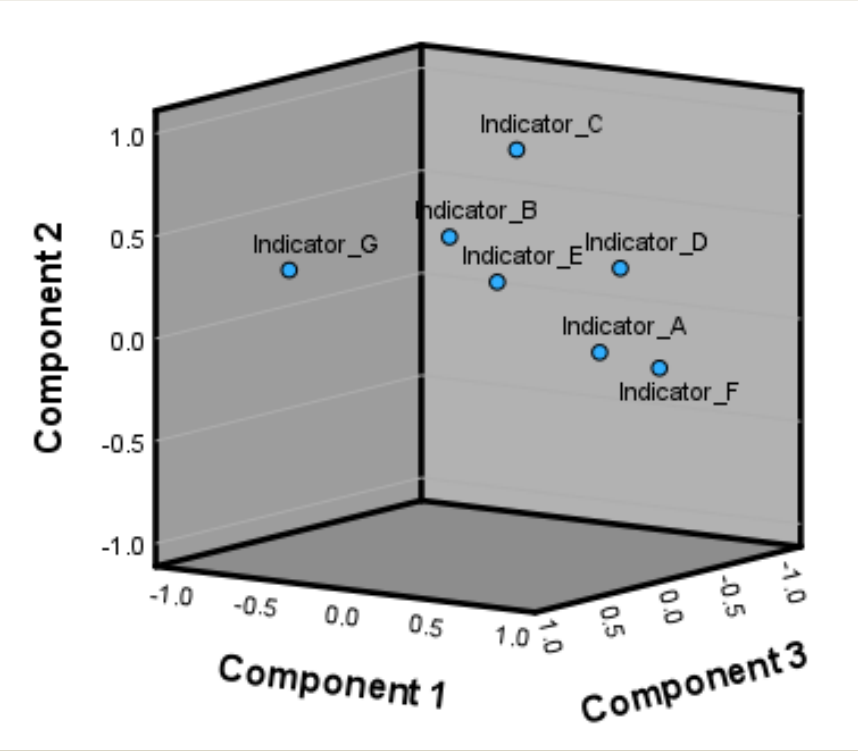


Low positive covariance



Low negative covariance

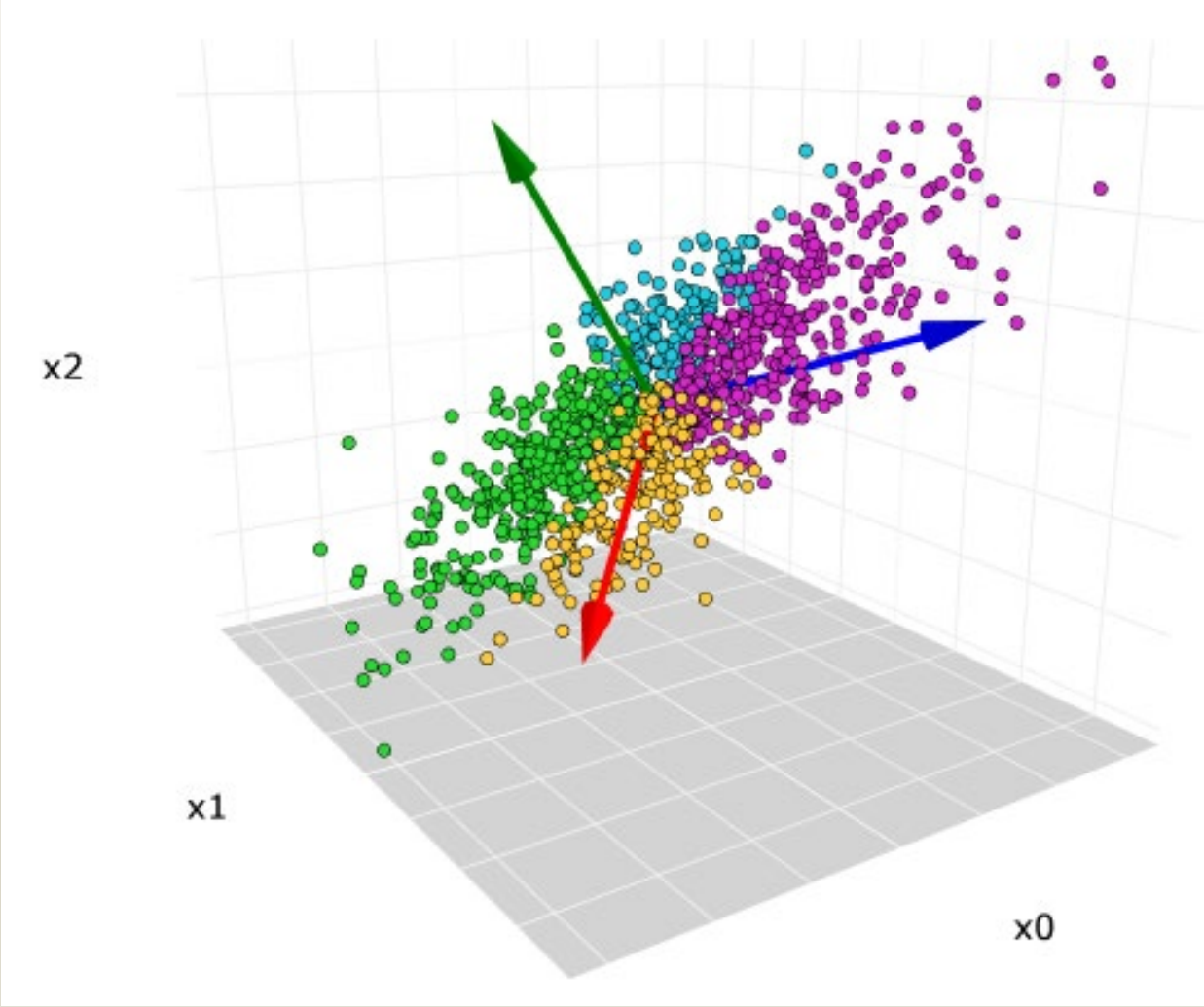
DECISION POINT #4 – METHOD EVALUTION



- PCA helps to simplify data by finding new features, called principal components, that capture the most significant patterns in the data. PCA first finds the axis of greatest variation, which is the line of best fit between the data points. This line is called the first principal component. Perpendicular lines of best fit are added to the model to explain the next greatest levels of variance, which make up the subsequent components.

- These principal components are ordered by importance, with the first component explaining the most variance in the data.

DECISION POINT #4 – METHOD EVALUTION



- The 3-dimensional graph shows what data transformed in a PCA model might look like.
- The transformed lines of best fit are called eigenvectors.
- The transformed data points are called eigenvalues.
- Eigenvectors are transformed 3-dimensionally because only 2 perpendicular lines of best fit can exist on a single plain.

DECISION POINT #4 – METHOD EVALUTION

Indicator	Components adjusted by percent of variance							Components summed	Indicator weight
	1	2	3	4	5	6	7		
A	0.092	0.000	0.007	0.004	-0.004	0.003	0.000	0.112	**12.9%**
B	-0.070	0.017	-0.024	0.020	0.000	0.000	0.000	0.131	**15.2%**
C	0.013	0.043	-0.008	-0.012	-0.006	0.000	0.000	0.082	**9.4%**
D	0.090	0.017	-0.008	-0.002	0.012	0.000	0.000	0.130	**15.0%**
E	0.068	0.019	0.027	0.013	-0.001	-0.002	0.000	0.130	**15.0%**
F	0.114	-0.007	-0.011	0.005	-0.002	-0.001	0.002	0.141	**16.3%**
G	-0.097	0.014	0.022	0.002	0.003	0.001	0.001	0.141	**16.2%**
Percent of Variance	43.0%	17.4%	15.3%	10.9%	7.3%	3.0%	2.0%		

- The table shows an example of a component matrix used to calculate indicator weights for a subdomain.
  - The number of components are determined by the number of indicators.
  - The indicator variances are weighted by the components' percent of explained variance.
  - The weighted variances are aggregated using their sum of squares. Sum of squares are used to scale positive and negative values by their distance from the mean.
  - The subdomain weights are then calculated from their weighted relative variance.

DECISION POINT #4 – RECOMMENDATION

1

The Methodology Workgroup recommends using principal component analysis to weight indicators for the first version of the Oregon Environmental Justice Mapping Tool.

2

The Methodology Workgroup requests flexibility to revisit the recommendation for Decision Point #4 during the sensitivity analysis (Decision Point #8) after the final set of indicators are selected.

3

The Methodology Workgroup also recommends transitioning to participatory weighting of indicators and domains using conjoint analysis for future versions of the Oregon Environmental Justice Mapping Tool. Participatory weighting should include community survey input and technical expert consultation.

DECISION POINT #4 – PCA RATIONALE

Environmental conditions impact health and quality of life unequally and therefore should not be weighted equally.

PCA is a measure of inequity that can tell us which environmental burdens and social disparities are the most inequitable in Oregon.

PCA can also tell us which Oregon communities are experiencing the greatest inequities.

There is an underlying assumption in using PCA for determining weights that the chosen indicators are important, comprehensive components of environmental equity.

DECISION POINT #4 – PCA NARRATIVE

- Let's say unemployment is an important indicator for communities, but all communities in the state are experiencing the exact same level of unemployment. How important would that indicator be for inclusion in equity decision-making?

- Now consider two indicators are important for communities, unemployment and household income. While unemployment has no variation (Variance = 0), household income is much lower in some communities (Variance > 0). Which of these two indicators would be more relevant for equity decision-making?

- From these two premises, we can conclude that variance within an indicator is an important factor in equity decision-making.

DECISION POINT #4 – PCA RATIONALE

- PCA cannot tell us whether being exposed to a particular environmental risk impacts health more than another environmental risk. For example, PCA cannot tell us whether long-term exposure to an air toxic is more harmful than exposure to a drinking water contaminant or whether living in a community with high wildfire risk is worse than living in a community with high flood risk.

- Weighting indicators by their contribution to health or quality of life would require identifying a common outcome for the subdomains and using regression to quantify the associations. We are currently unaware of an outcome that works for all the EJ Mapping Tool subdomains.

DECISION POINT #4 – CONJOINT ANALYSIS RATIONALE

- HB4077 requires Oregon community participation in the development of the Environmental Justice Mapping Tool.
- Conjoint analysis will give us greater opportunities to incorporate community concerns into indicator weighting.
- Unfortunately, the time and resources required for setting up community surveys with equitable demographic and socioeconomic representation and analyzing the data prevent us from using conjoint analysis for the first version of the Oregon Environmental Justice Mapping Tool.
- The EJ Mapping Tool Leadership Team will begin building surveys during development of the first version of the EJ Mapping Tool to collect statewide input from community members for version two of the tool.

ADOPTED DECISION POINT 4

Principal component analysis

Conjoint analysis for future versions