

Challenges and Opportunities for Non-Powered Dams: *Improving Classification and Data Access*

Oak Ridge National Laboratory
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ORNL is managed by UT-Battelle, LLC for the US Department of Energy

Welcome

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Introduction

ORNL Non-Powered Dam Classification Team:



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Introduction



Organizations Registered

Advanced Hydro Solutions	Oregon Department of Fish and Wildlife
Association of State Dam Safety Officials	Percheron Power
Black & Veatch	PNNL
Cadens, LLC	Power & Electrical Energy Resources
Current Hydro	Rose Company, LLC
Duke Energy	Schnabel Engineering
EPRI	Science, Technology, and Innovation Policy Analysis & Education, LLC
Farmers Conservation Alliance	Southeast Aquatic Resources Partnership
GE	Southwestern Power Administration
Guidehouse	Transitional Capital Management
Hydropower Reform Coalition	University of Maryland
INL	University of Missouri
Knight Piesold	US Bureau of Reclamation
Low Impact Hydropower Institute	US Department of Energy
Natel Energy	Vermont Department of Environmental Conservation
National Hydropower Association	Vermont Natural Resources Council
Nelson Energy	Wisconsin Department of Natural Resources
New England Hydropower Company, LLC	
NLine Energy	
NREL	

Workshop Objectives

- Better understand the backgrounds, priorities, and needs of various stakeholders involved with non-powered dams
- Present a vision and framework for tackling NPD classification
- Solicit feedback from a diverse suite of potential users of classification research products and tools



Images courtesy of Scott DeNeale, ORNL

Workshop Agenda

Overview of NPD Data Challenges

ORNL's Approach to NPD Classification

Q & A and Roundtable Discussion

Next Steps

Ice Breaker

Poll + Voting: Where are you?

- What is the dam nearest to your home?
- Use sticky dots to vote for which dams you have heard of (max 10 votes).

Overview of NPD Data Challenges

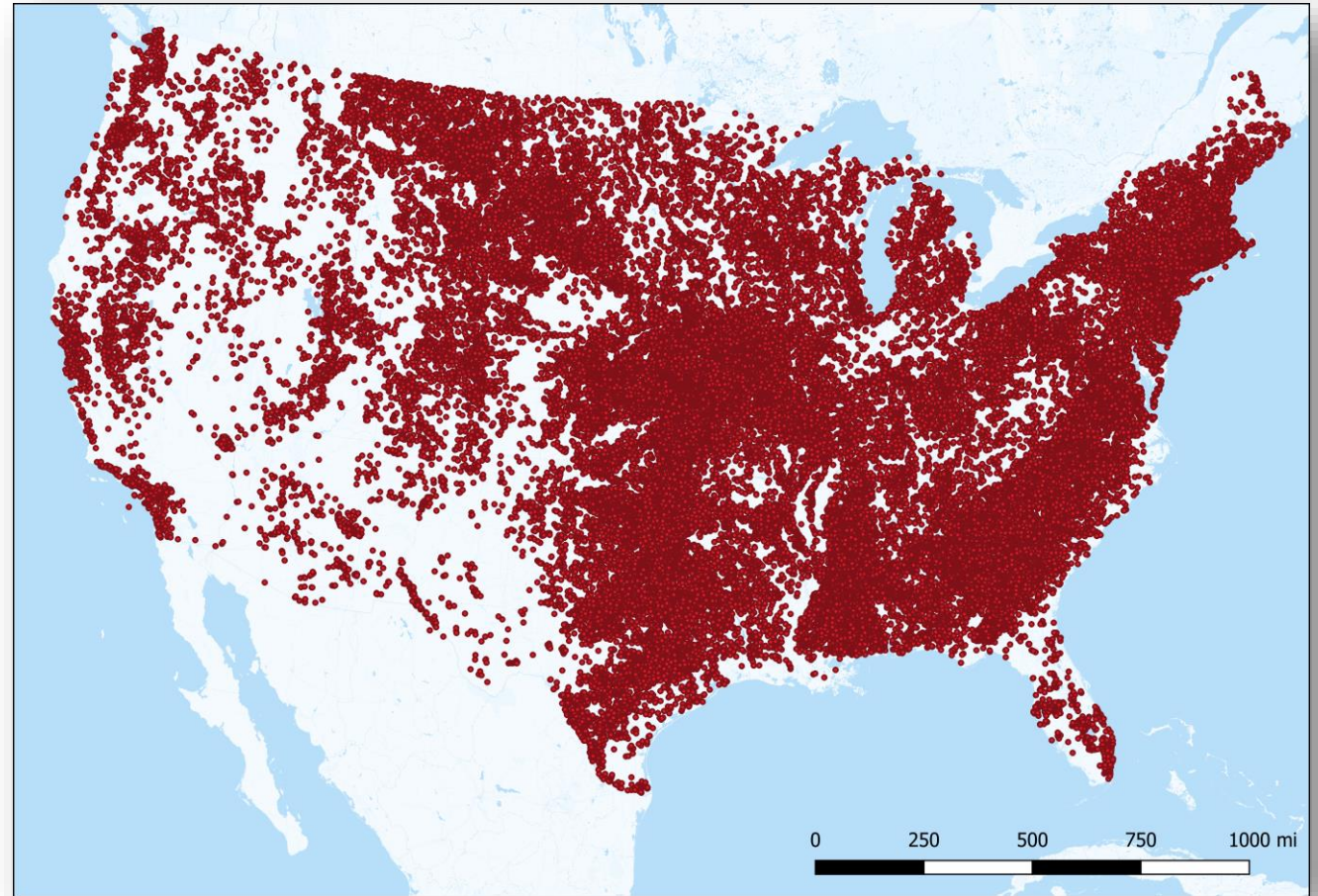
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Challenge #1. Large population of dams in the US

- Population of dams in the US can be overwhelming to deal with
 - More than 90,000 dams documented by the USACE National Inventory of Dams
 - ~97% are non-powered dams
 - Wide range of characteristics and conditions (design, operation, environmental, socio-economic)



Data source: USACE National Inventory of Dams

Challenge #2. Data availability

- Disparate data sources
 - Dam-specific
 - State or regional
 - Colorado DWR, SARP, ...
 - National
 - USACE, FEMA, Stanford, ORNL, ...
 - Global
 - ICOLD, Global Dam Watch, ...
 - Dam-related
 - USGS, NRCS, EPA, NatureServe, ...
- Accessibility
 - Open vs controlled access
 - Data display and extraction

The screenshot displays the USACE National Inventory of Dams Interactive Map and Charts interface. The top navigation bar includes links for Welcome, Interactive Map & Charts, Advanced Searches, Log in, Request A Username, Forgot Password, Downloads (Public), and Help. Below the navigation bar, there are filters for 'Select a region: TENNESSEE', 'Select a county: Bradley', and 'Select a measure: -SELECT-'. The main content area shows a 'Summary for Bradley, TN' with several key statistics: 15 Total Dams, 44 Average Age of Dam, 50 % of High Hazard Potential Dams with an Emergency Action Plan, 40 % of Dams Regulated by State Agency, 0 % of Dams Regulated by Federal Agency, and 0 % of dams with hydropower. A map of Bradley, TN, is shown with a search bar and a map view. To the right of the map, there is a 'Details of Dam' section for 'STONE LAKE' with various attributes like NID ID, River, County, State, Owner Name, NID Height, NID Storage, Dam Type, Primary Purpose, Construction Date, and Inspection Date. Below the map, there is a search form for the 'NPDP Dams Database' with fields for Dam Name (partial name ok), Dam Type, Hazard Class (US Dams Only), Foundation Type, Dam Height (m), Country, State/Province, County (US Dams Only), Main Purpose, Normal Reservoir Storage (m3), and a Search button. The search form also includes range selection options (between and and) for Dam Height and Normal Reservoir Storage. The bottom right corner of the search form indicates 'Table Last Updated: 2019-10-9'.

USACE National Inventory of Dams Interactive Map and Charts

Summary for Bradley, TN

- 15 Total Dams
- 44 Average Age of Dam
- 50 % of High Hazard Potential Dams with an Emergency Action Plan
- 40 % of Dams Regulated by State Agency
- 0 % of Dams Regulated by Federal Agency
- 0 % of dams with hydropower

Map

Enter Name of Dam

NPDP Dams Database

Home » NPDP Dams Database

Main Menu **Dams Directory** Dam Incidents Consequences Failure Modes Lessons Learned Modifications Digital Library Photo Library

Dam Name : (partial name ok)

Dam Type :

Hazard Class : (US Dams Only)

Foundation Type :

Dam Height (m) between: and:

Country :

State/Province :

County : (US Dams Only)

Main Purpose :

Normal Reservoir Storage (m3) : between: and:

Search

Table Last Updated: 2019-10-9

Details of Dam

Dam Name: STONE LAKE

Other Dam Name: -

NID ID: TN01114

River: CANDLES CREEK

County: BRADLEY

State: TN

Owner Name: Private

Owner Type: CLEVELAND EXIT 20, LLC

NID Height: 243 feet

NID Storage: 42 acre-feet

Dam Type: Earth

Primary Purpose: Recreation

Construction Date: -

Inspection Date: Significant

Inspection Date: 7/6/2017

Inspected Dam: Not Required

Regulated Dam: N

Regulatory Agency: -

Data Provided to NID: 07/31/2018

Challenge #3. Data quality

- Differences in coverage
 - Temporal/spatial coverage
 - Temporal/spatial resolution
 - Site-specificity
- Accuracy and completeness
 - Versioning
 - Documentation
- Assumptions behind different datasets
 - Thresholds for inclusion
 - Observed vs modeled data
 - Methodology
 - “One-size-fits-all” classifications

Information in the National Inventory of Dams

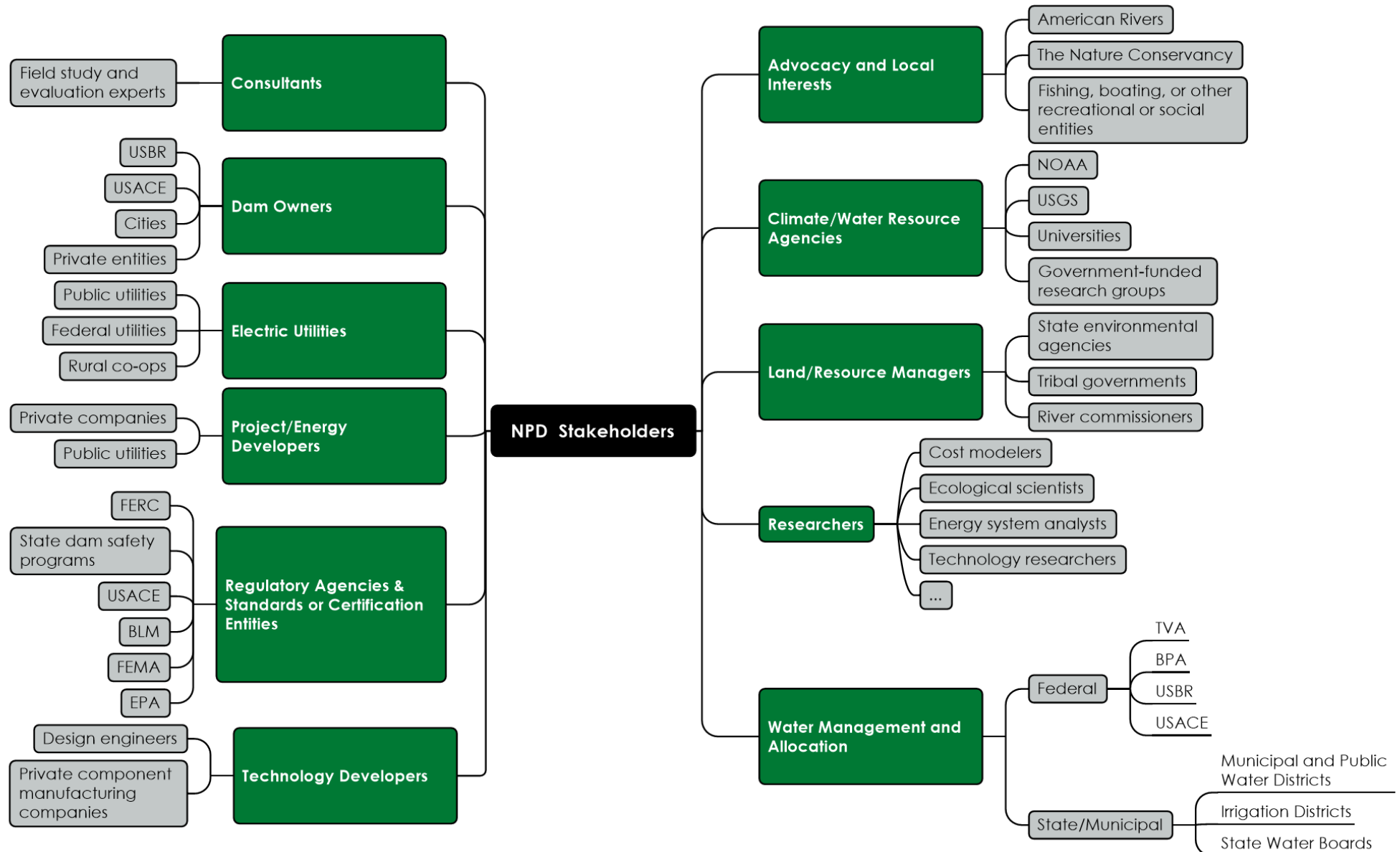
The NID consists of dams meeting at least one of the following criteria:

1. High hazard potential classification - loss of human life is likely if the dam fails.
2. Significant hazard potential classification - no probable loss of human life but can cause economic loss; environmental damage, disruption of lifeline facilities, or impact other concerns.
3. Equal or exceed 25 feet in height and exceed 15 acre-feet in storage.
4. Equal or exceed 50 acre-feet storage and exceed 6 feet in height.

The goal of the NID is to include all dams in the United States that meet these criteria, yet in reality, is limited to information that can be gathered and properly interpreted with the given funding.

Source: FEMA

Challenge #4. Variety of stakeholders and interests in dams



Interactive Activity

Select your role + Scoring: What are your primary interests in NPDs?

- Select a stakeholder role prior to doing this activity.
- Please rate the relevance of each topic to your own interests by selecting an option 1-5 using the scale below. After you have rated all items, click the checkmark at the bottom of the screen.
 - Environmental impacts
 - Hydropower development
 - Specific technology applications
 - Fish passage
 - Navigation
 - Regulation/Licensing
 - Safety
 - Dam removal
 - Dam/Reservoir operation and water resource management

Motivation for Classification

- Dams represent complex systems
 - Large population of dams in the US
 - Variety of stakeholders and interests in dams
- Data challenges
 - Data availability
 - Data quality
- Meeting diverse objectives requires:
 - Collecting/synthesizing diverse datasets
 - Building data retrieval/visualization/etc. from the ground up



- Classification can help improve understanding and inform decision-making



**Framework for
tackling NPD
classification**

- Time/energy intensive
- Repeated by each stakeholder & for each objective

Overview of NPD Data Challenges

ORNL's Approach to NPD Classification

Q & A and Roundtable Discussion

Next Steps

ORNL's Approach to NPD Classification

1: Define the building blocks



2: Select data sources and configure classes



3: Arrange the building blocks



4: Apply Data



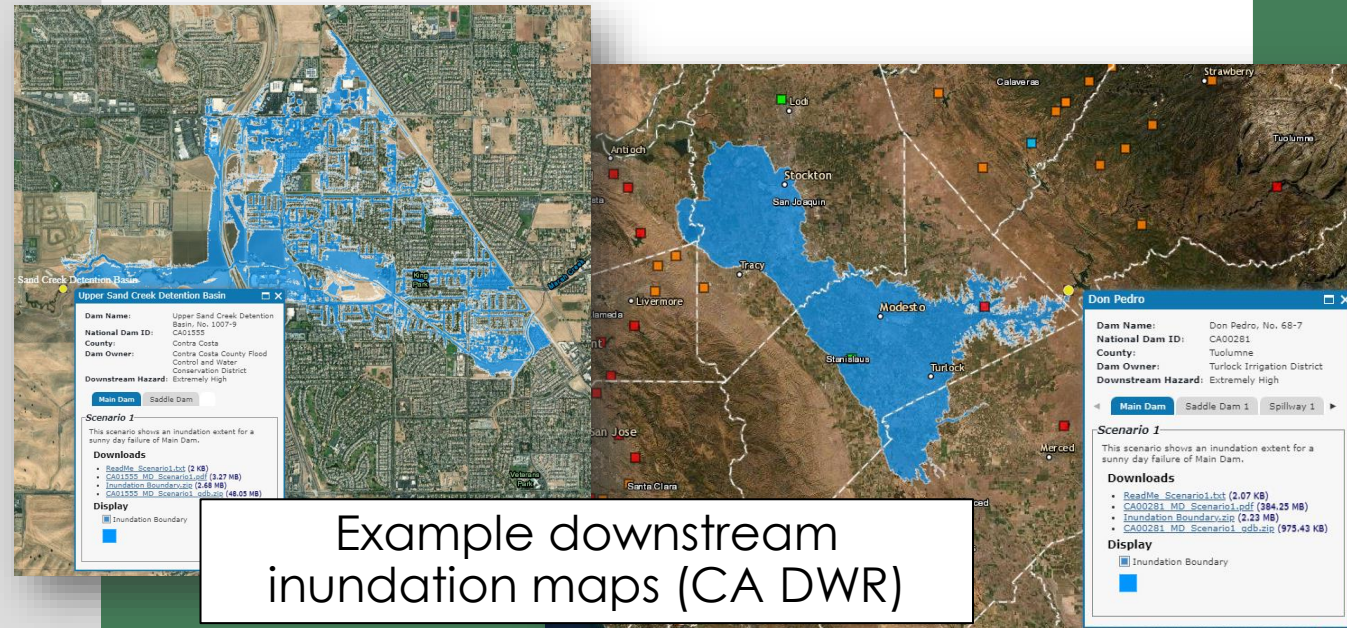
Interactive Activity

Poll + Voting + Sticky Notes: Example Brainstorming characteristics, data sources, and classes

1. What characteristics would that researcher be interested in?
2. Where would they get that data?
3. How would dams be divided into classes for these characteristics?

Consider the specific use-case scenario:

A researcher wants to understand vulnerabilities (e.g. # of people) downstream of dams in their state for dams of various sizes.



ORNL's Approach to NPD Classification

Step 1: Define the building blocks



Building blocks of classification:

- Characteristics
- Data that support those characteristics from a variety of sources
- Possible definitions for classes

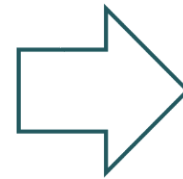
ORNL's Approach to NPD Classification

Step 1: Define the building blocks



Building blocks of classification:

- Characteristics
- Data that support those characteristics from a variety of sources
- Possible definitions for classes



Step 2: Select data sources and configure classes



Make selections about:

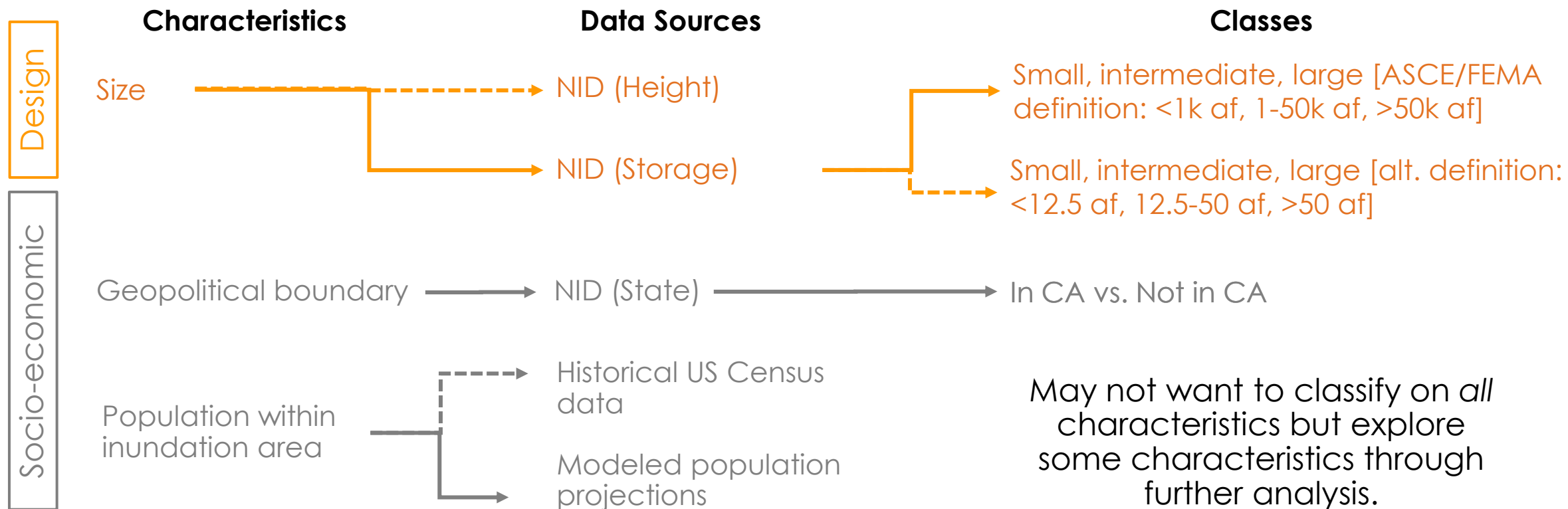
- *which* characteristics,
- *which* data sources, and
- *how* to define classes

ORNL's Approach to NPD Classification

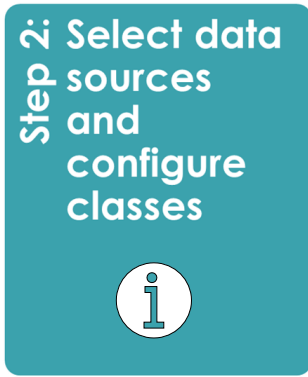
Step 2: Select data sources and configure classes



Example objective: *How does the # of people within inundation/flooding zones of dams in California vary by dam size?*



ORNL's Approach to NPD Classification



Made selections about:

- which characteristics,
- which data sources to use,
- how those classes would be defined

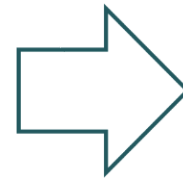
ORNL's Approach to NPD Classification

Step 2: Select data sources and configure classes



Made selections about:

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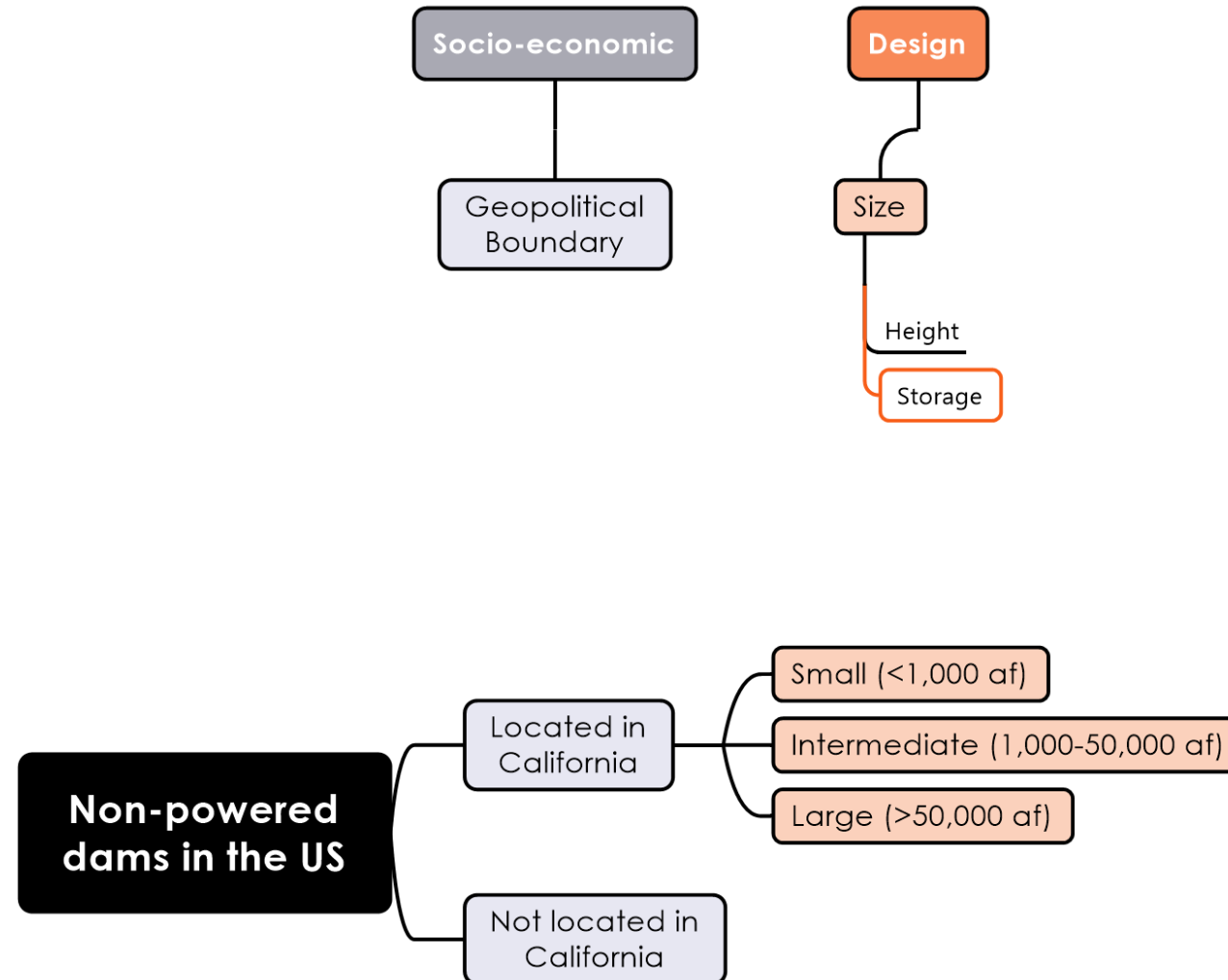
Step 3: Arrange the building blocks



Put the pieces together to create a taxonomy

ORNL's Approach to NPD Classification

Step 3: Arrange the building blocks



ORNL's Approach to NPD Classification

Step 3: Arrange the building blocks



Arranged the pieces to create a taxonomy

ORNL's Approach to NPD Classification

Step 3: Arrange the building blocks

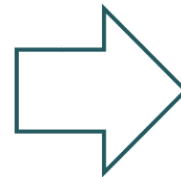


Arranged the pieces to create a taxonomy

Step 4: Apply Data

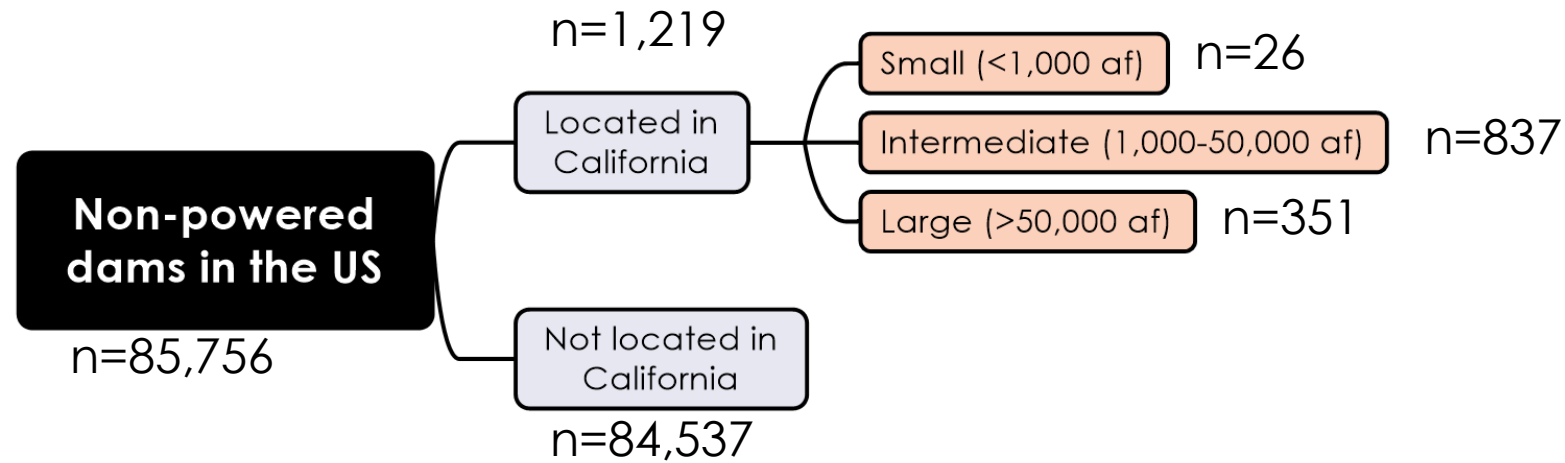


Apply the selected data to the taxonomy structure

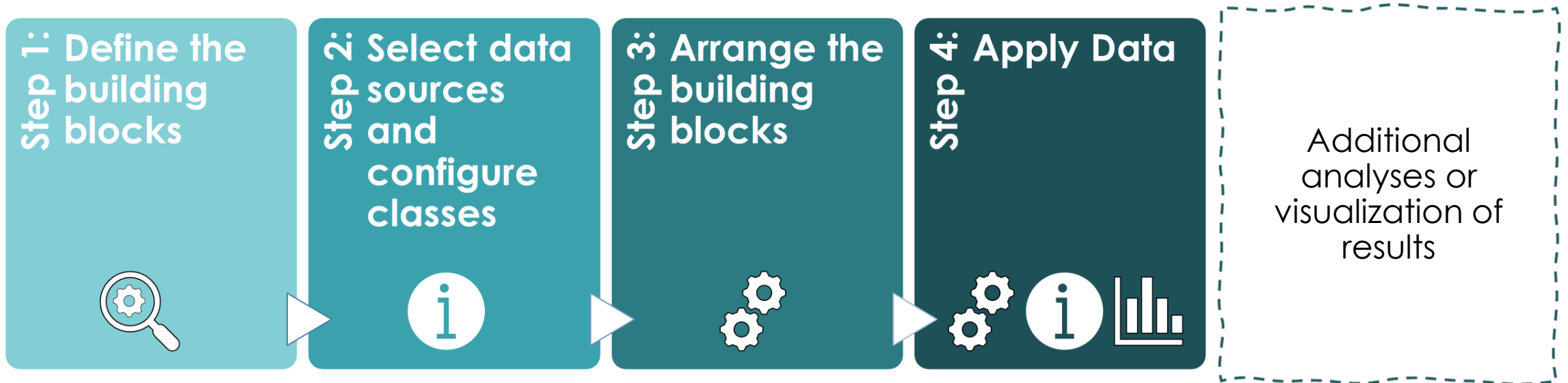


ORNL's Approach to NPD Classification

Step 4: Apply Data

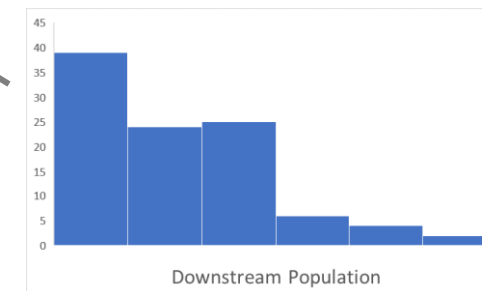
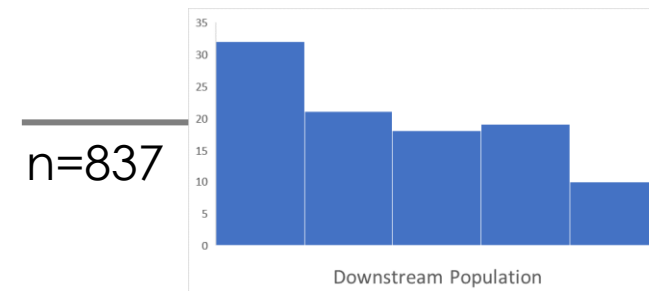
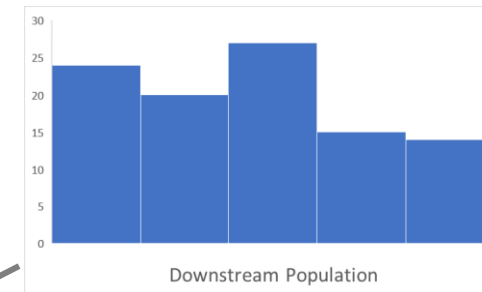
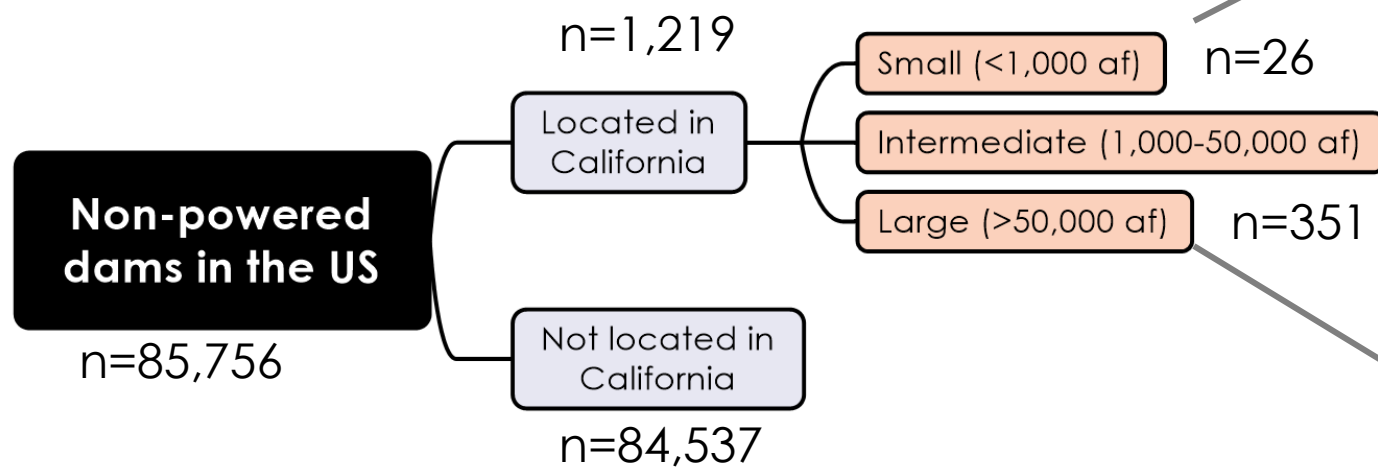


ORNL's Approach to NPD Classification



ORNL's Approach to NPD Classification

Step 4: Apply Data



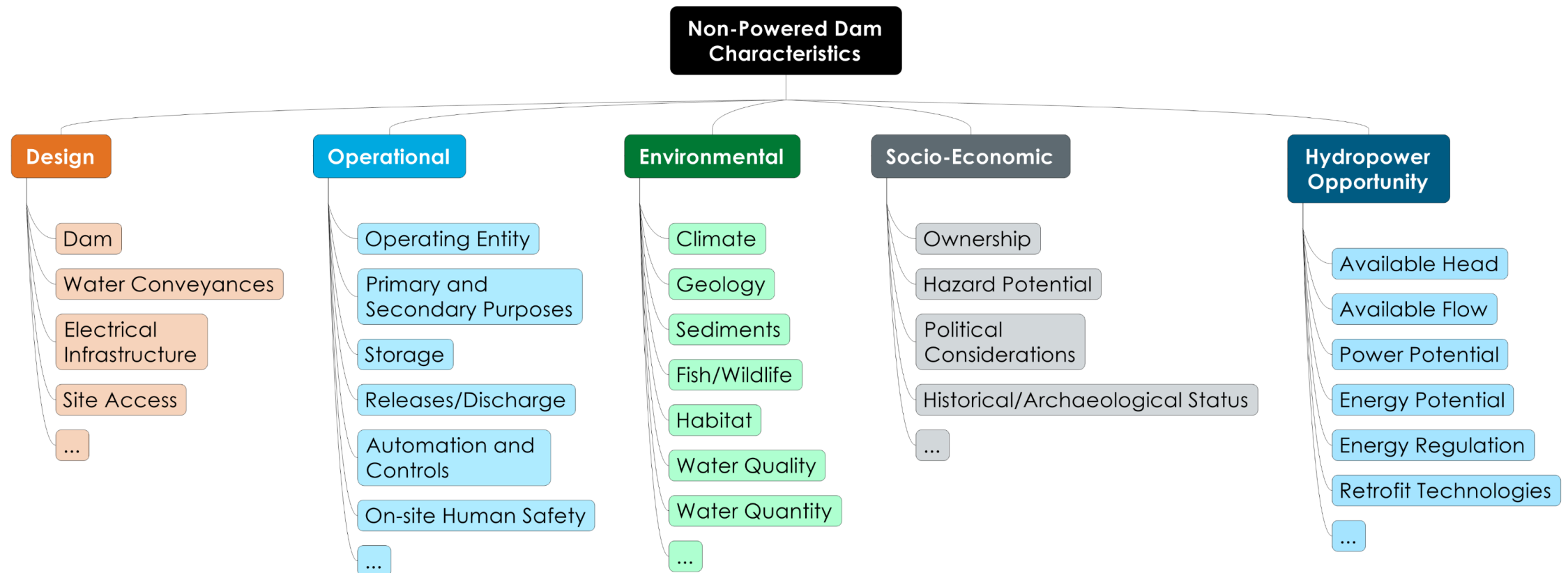
Interactive Activity

Poll + Voting + Sticky notes

- **What characteristics or parameters do you rely on during analyses or decision-making?**
- **Use sticky dots to indicate that you also are interested in a characteristic**
- **With the top 5-6 characteristics, what data sources do you typically use to get information about these characteristics?**
- **How would you define classes for the characteristics that we have discussed?**

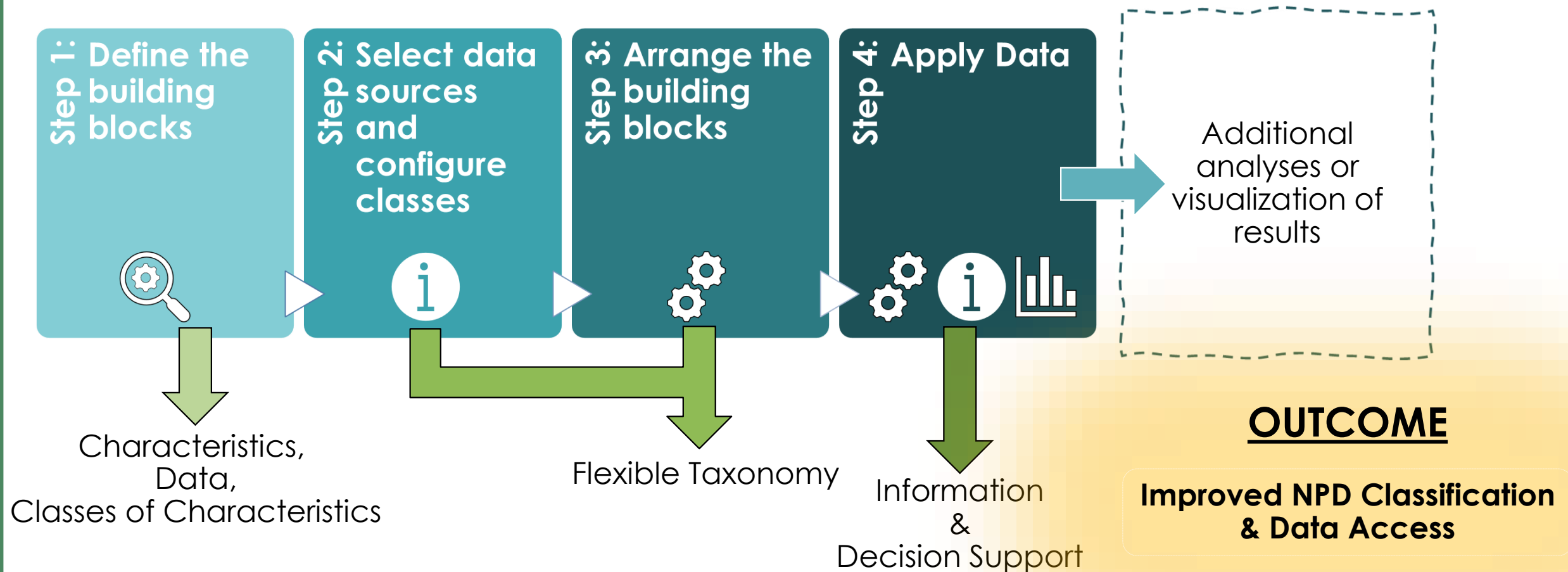
ORNL's Approach to NPD Classification

Inventory of building blocks



ORNL's Approach to NPD Classification

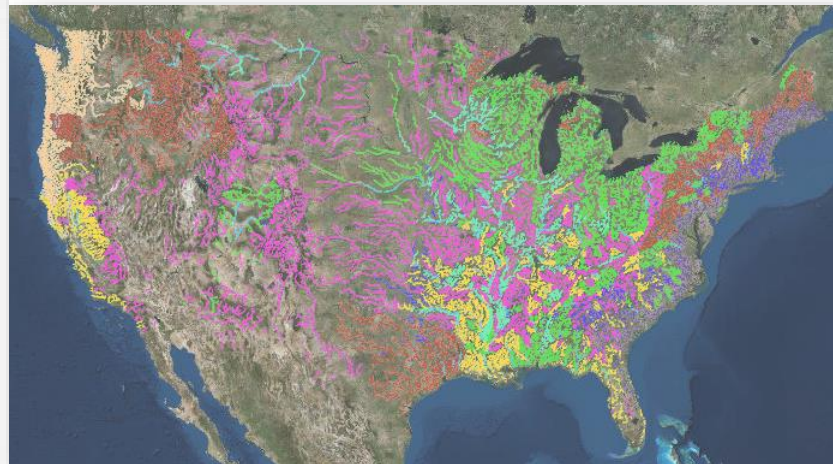
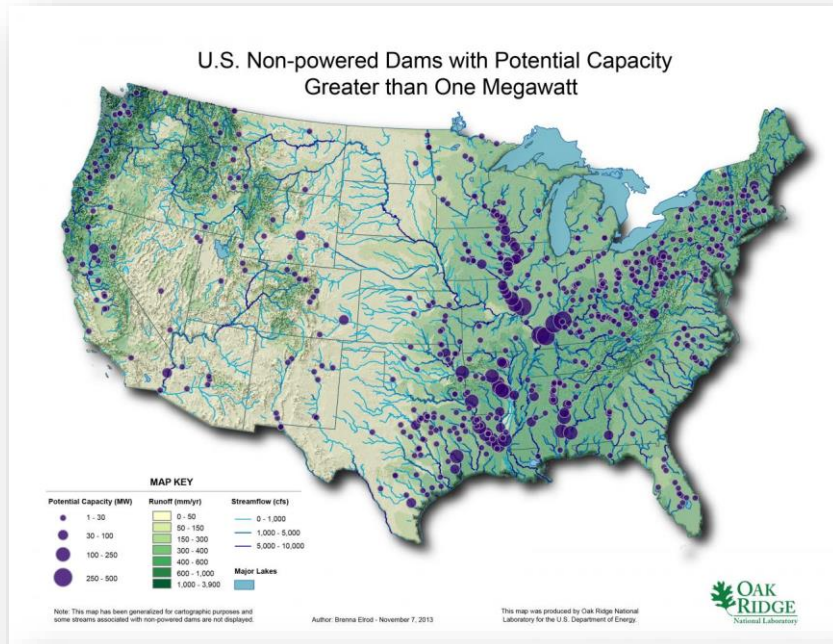
Flexible Taxonomy Framework



ORNL's Approach to NPD Classification

- Benefits of classification:
 - **Provides an efficient way to tackle problems involving large #s of dams**
 - **Enables summaries and comparisons:** Understand how the population of dams is divided and gain context by comparing results among classes
- Benefits of the flexible taxonomy approach:
 - **Customized approach:** Tailor the structure of the taxonomy to the specific priorities and objectives of the individual
 - **Accounts for uncertainty/data deficiencies:**
 - **Identify gaps in available data:** some characteristics may not currently have supporting datasets or may suffer from inconsistent data
 - **Enable sensitivity analysis:** Understand how relaxing or constraining class definitions or using different datasets will affect results

NPD classification & data access: research connections



Source: Oak Ridge National Laboratory

- **Low Impact Hydropower**

- Understand the population of dams to better inform:
 - *Hydropower opportunity*
 - *Design approaches*
 - *Technology solutions*
 - *Site/environmental assessment needs*
 - *Operational considerations*
- Identify commonalities that support standard modular hydropower development:
 - *Standard, modular technologies that are environmentally compatible*
 - *Cost-optimized project development*

- **Cost Modeling**

- Inform baseline cost estimation for benchmarking
- Improve cost modeling capabilities

- **Data Access**

- HydroSource: <https://hydrosource.ornl.gov/>

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Next Steps

- **Workshop #2 (Spring 2021):** review a prototype classification/dam exploration tool
- **Post-Workshop Questionnaire**

Thank you for attending!

Questions/Comments/Feedback:

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<https://smh.ornl.gov/>

