



Data Quality Standards for Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefields in White Sands National Monument, New Mexico

Natural Resource Report NPS/CHDN/NRR—2018/1841



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Abstract

The purpose of this report is to document the data quality standards used by the Chihuahuan Desert Network (CHDN) for activities related to the collection, processing, storage, analysis, and publication of monitoring data as described in the Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018). The policies and procedures documented or referenced in this data quality standard complement the data quality standards for other monitoring activities conducted by the Chihuahuan and supplement the data management plans for the I&M networks (Richie 2009 and Angell 2005). This report serves as a guide for all Chihuahuan Desert Network personnel who are involved in protocol/program activities, or users of the data collected, analyzed, and reported heretofore and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Version 1.00

Revision History Log

Previous version#	Revision date	Author	Changes made	Reason for change	New version #
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Introduction

The National Park Service (NPS) Inventory and Monitoring Program was established by an act of Congress in 1999 to provide more than 270 national park system units a core suite of baseline minimum scientific information (inventories) and to identify and implement long-term monitoring of high-priority measurements of resource condition in those units (Fancy et al. 2009). The overarching purpose of natural resource monitoring in parks is to develop scientifically sound information on the current status and long-term trends in the composition, structure, and function of park ecosystems, and determine how well current management practices are sustaining those ecosystems.

The purpose of this Data Quality Standards (DQS) is to document the standards, policies, and procedures used by the Chihuahuan Desert Network (CHDN) for activities related to the collection, processing, storage, analysis, and publication of monitoring data as described in the Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018).

The policies and procedures documented or referenced in this quality-assurance plan complement the quality-assurance plans for other monitoring activities conducted by the Chihuahuan Desert Network and supplement the quality management plan for the NPS Inventory & Monitoring Program (Richie 2009 and Angell 2005). The DQS also serves as a guide for CHDN personnel who are involved in protocol/program activities and as a resource for identifying memoranda, publications, and other literature that describe associated techniques and requirements in more detail.

Protocol Overview

The Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018) describes the background, goals and objectives, sampling design, field methods, data management, reporting and analysis, personnel requirements, and operational requirements for monitoring dunes at White Sands National Monument (NM).

The objectives of the protocol are:

- 1) To determine if the dunefield is stable (e.g. is increasing or decreasing in size or moving) and
- 2) To determine if the dunefield is maintaining its integrity (e.g., to measure if vegetation and soil moisture are changing over time to evaluate whether the conditions that create and maintain the dunefield are changing).

Data and information are shared with parks, NPS staff, and the public through a variety of reports and products. In five year intervals, remotely sensed data will be analyzed comparing past metrics with current ones. A status (and trend when enough data are gathered) report will be produced. Additional products may also be derived from the analyses and reports.

Protocol Activities and Modules

Data are collected or derived as a part of the Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018). Within each module, a variety of activities occur (Table 1).

Sampling Design

A remote-sensing approach will be used to monitor whether the entire dunefield is changing in size (e.g., increasing or decreasing), and/or if the dunefield is moving or migrating from its current and historical location, and changes in the integrity of the ecosystem (e.g., vegetation greenness, soil moisture) (Table 1). Remote sensing can also help assess changes to ecological integrity by measuring aspects of the dunefield, primarily vegetation type and spatial coverage as an index of ecosystem changes. This protocol uses remote sensing and other technological tools such as GIS: Landsat, Worldview, Naip Imagery, ASTER (Advanced Spaceborne Thermal Emission and Reflection), MODIS (Moderate-Resolution Imaging Spectroradiometer) satellite data, EVI (Enhanced Vegetation Index) and NDVI (Normalized Difference Vegetation Index) (see Narrative Chapter 4 and (respective SOPs), in conjunction with the network's LiDAR and vegetation monitoring, to achieve its objectives.

The use of remote sensing to monitor changes in boundary conditions between environments is well

documented in the refereed scientific literature (e.g., Grigio et al. 2005). The automatic extraction of data from classified remote-sensing images provides an objective way to analyze changes in dune systems through time.

Data Quality Objectives

Data quality values and standards for implementation are provided in Table 3 through Table 6. Good image registration is essential for change detection.

Acceptable root mean square errors should be maintained below one pixel based on not less than 25 image registration points in the image. Thus, the dunefield area can be effectively delineated with image-difference techniques after careful registration and radiometric normalization because the perimeter-to-area ratio is small. For this reason, image-registration error is a negligible component of estimated change in area.

Table 1. Protocol activity matrix for Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018).

Category	Activity Number	Activity	Description
Data Acquisition	1	Satellite Images	Images Obtained from Satellite Data Sources” Naip, Landsat, Worldview, ASTER, MODIS.
	2	Temp/Precipitation Data	Data obtained via Daymet website and contracts with Climate Analyzer. Data Analyzed for soil moisture, water balance, and greenness per SOPs 4, 5, and the supplemental attachments in SOP 5.

Table 2. Metrics that assess the stability of the White Sands dunefield using dunefield characteristics for Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018).

Metric	Metric Description	Rationale	Measure	Requirements
Dunefield Size: Area	Metric designed to index the overall size (area) of the dunefield.	Changes to perimeter margins index dunefield movement, but it is unclear if those movements represent an actual true dunefield shift or are merely oscillations in dunefield location. The overall area measurement would provide a clear signal of changes in the dunefield size.	Change in area through time.	GIS exercise using high-resolution geo-referenced remote sensing layer available within 5-year (maximum) time frequency. Landsat or NAIP.
Dunefield Perimeter Margins (North, South, East, West)	This metric is designed to index directional changes in the location of the dunefield. Along each perimeter margin (N,S,E,W), 100 pre-determined points will be monitored over time to ascertain perimeter boundary movement in a particular direction. Movement will be denoted as (+) or (-) for each point relative to each margin for each subsequent time sequence comparison. Net differences in location for each point, and for each ordinal margin, will be tracked through time, along with the point having the largest (+) and (-) movement individually along a particular margin.	Indexing changes in the location of the dunefield perimeter margins relative to the four ordinal directions will help identify whether the field is moving and the rate of movement.	Net change in the ordinal location of each respective dunefield margin (N,S,E,W).	GIS exercise using high-resolution geo-referenced remote sensing layer available at a 5-year (maximum) recurrence time frequency. Landsat or NAIP.
Dunefield Centroid	The centroid represents the calculated geographic center of the entire dunefield. The centroid calculation uses all 400 margin points in the Dunefield Perimeter Margin metric described above (100 each for North, South, East, and West margins).	The centroid is a less-sensitive measure of dunefield movement but provides a more powerful general index of overall dunefield movement. While margins may oscillate in some dynamic equilibrium by moving forward and backward through time, changes in the centroid pinpoint a larger-scale change to the field.	Change in calculated location of centroid over time. Metric is the geographic center of all 400 points derived from the margin locations.	GIS exercise using high-resolution geo-referenced remote sensing layer available at a 5-year (maximum) recurrence time frequency. Landsat or NAIP.
Lake Lucero (Sand Source) Area	Metric designed to index the area of Lake Lucero, the source of sand on Alkali Flat.	Lake Lucero and corresponding Alkali Flat is the source of gypsum for the White Sands dunefield.	Change in area through time.	GIS exercise using high-resolution geo-referenced remote sensing layer available within 5-year (maximum) time frequency. Landsat or NAIP.
Location and Area of Parabolic Dunes	Subset of dunefield area referencing a particular morphological type of dune associated with vegetation which helps to create this dune type.	The Barchan-Parabolic Transition occurs with declining sand flux that triggers an abrupt increase in vegetation density, which in turn leads to changes in groundwater depth and salinity—showing that aerodynamics, sediment transport, and ecohydrology are tightly interconnected in this landscape (Jerolmack et al. 2012).	Change in location of the transition zone and area of parabolic dunes through time for the Greater White Sands dunefield.	GIS exercise using high-resolution geo-referenced remote sensing layer available within 5 year (maximum) time frequency. Landsat or NAIP.

Table 3. Data Quality Values (DQVs) for Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018).

Category	Data Quality Value	Definition	Protocol Considerations
Intrinsic Data Quality	Accuracy	Measurement accuracy reflects the true value of the parameter being observed as applied to distance, area, temperature, precipitation, and moisture. Includes components of precision and bias.	Image accuracy provided by respective satellite and ground truthed to permanent structures (i.e., buildings) within the park. Addressed in SOP2, SOP 3, SOP4, SOP5 and supplements to SOPs 4 and 5.
	Representativeness	Measurements represent conditions at the time of sampling. Combined with accuracy, leads to repeatable data collection.	The entire dunefield is being surveilled and thus is representative of itself.
Contextual Data Quality	Comparability	The degree to which data can be compared among sample locations, data sources, or periods of time.	The dunefield is the sample unit. There are no replicates. Satellite images will be from the same satellites over time; otherwise geo-corrected using permanent structures. Addressed in SOP 2.
	Timeliness / Currency	How recent the data need to be to be considered valid for their intended use.	Data are collected every 5 years from that year's satellite. Climate data is collecting every hour and downloaded via ClimateAnalyzer.
	Completeness	All data/ measures required to evaluate accuracy representativeness are present; incomplete data sets (either at a location, across sampling locations, or over time) lose utility or relevance. Data records contain values as planned across the period of record.	Images will be obtained from the same satellites using the same methodologies. Any deviation (per satellite discontinuance), will require tandem data normalization so different satellite image types can be calibrated against each other and use permanent structures for georeferencing.
Representational Data Quality	Consistent Representation	Use of standard definitions when describing data quality or resource quality based on data	There are no Provisional Data. Satellite images are permanent records obtained from each source agency/ source.
Data Accessibility	Secure	Access to data, products, and systems limited to appropriate audiences.	Protected data may be released in limited cases only with park Superintendent or Chief of Resources approval following park procedures. Networks also are developing sensitive information plans.

Table 4. Measurement Quality Objectives for Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018).

Module / Parameter	Measure / Quality Indicator	Quality Objective
Site Characterization	Naip Imagery	± 1m (horizontal)
	Worldview Imagery	± 1m (horizontal)
	Landsat Imagery (various)	± 3-15 m (horizontal)
	MODIS NDVI/EVI	Spectral imagery which signals photosynthetic activity. Detailed in SOP 4
	Precipitation	Derived through synthesized Daymet calculations for WHASA. Initial recordings from proximal weather stations + 0.001 m (SOP 5 and supplements).
	Temperature	Derived through synthesized Daymet calculations for WHASA. Initial recordings from proximal weather stations + 0.1oC (SOP 5 and supplements).

Table 5. Taxonomic standards (only if vegetation-specific metrics are later added to the analysis) for Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018).

Category	Activity	Standard to be Used	Reference / Authority
Collection of Observational Data	Ground-truthed Vegetation	Field: Subject Matter Expert	Field crew lead or park staff w/ vegetation identification proficiency

Table 6. Data Protection standards for Dune Stability and Integrity Monitoring Protocol for Gypsum Dunefield in White Sands National Monument, New Mexico (Bozek et al. 2018). With the exceptions noted, all data collected are to be made publicly available in a timely fashion.

Category	Type of Data	Level of Protection	Rules for Dissemination
Resource Data and Information	Publicly Available Satellite Imagery	No protection	None
Personally Identifiable Information	Non-NPS staff information	Legally Protected	All but first name and last initial redacted from public release

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