- Best Practice -

Custom Coordinate System in Kingdom 2021/2017

Exploration Dept., Sirte Oil Company, Libya
Prepared by: Marcus Zou (mzou@sirteoil.com.ly)

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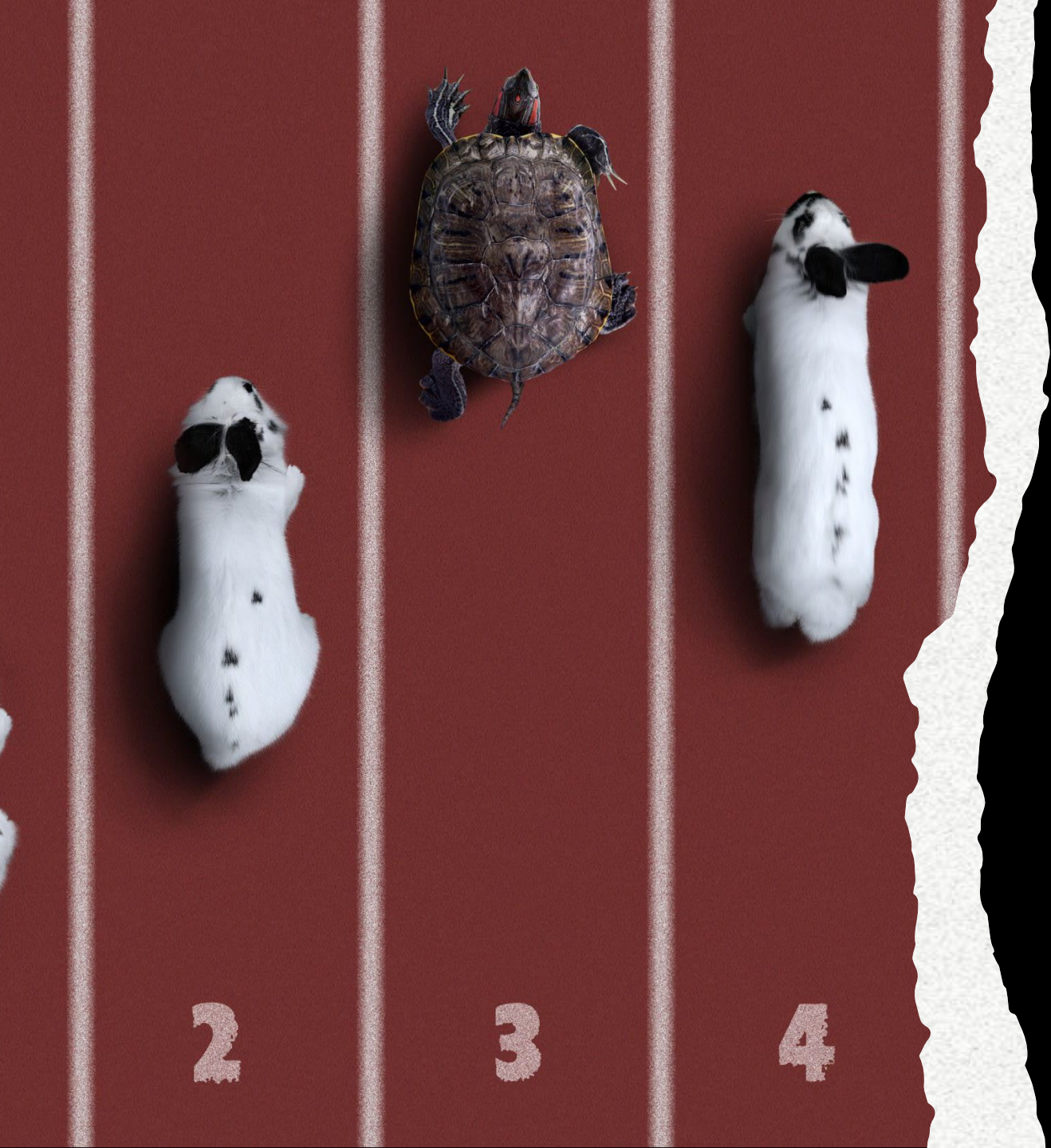
Scenarios to Apply a Custom Coordinate System

Business/Operation Scenarios and Proposal

1. You are going to work on a dataset (seismic, well, or culture), which does not fall into any natively built-in Coordinate Reference Systems (“CRS”). Then you may position your datapoints wrongly.

2. You failed to import some well/seismic/culture data into your working project, due to the to-be-imported data bearing a different CRS against your working project.

Proposed Solution: Build a **Custom CRS**



A Primer of Coordinate Systems

What's a Coordinate System?

Coordinate Reference System (CRS):

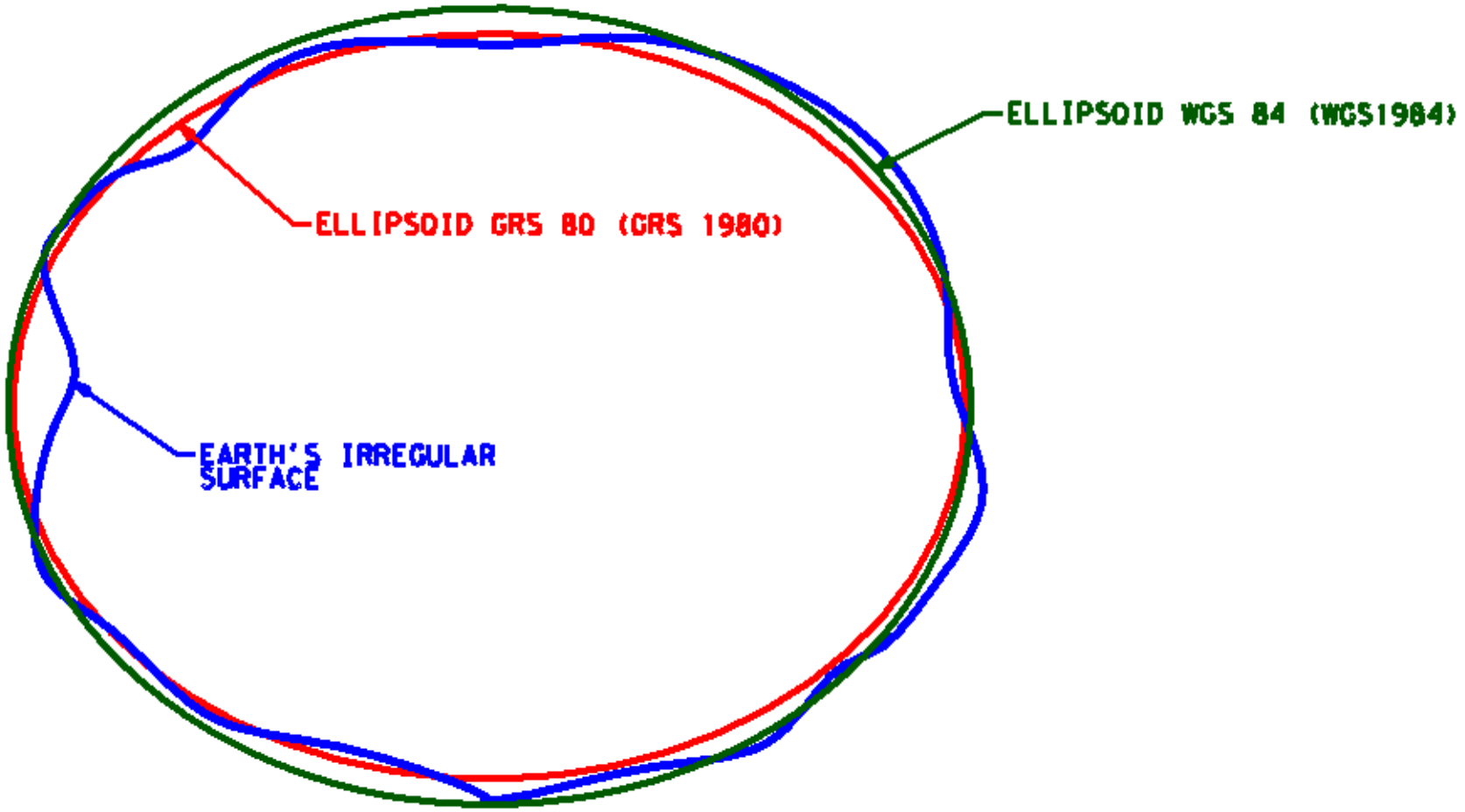
- **The mechanism to define, how the two-dimensional, projected map is related to real locations on the earth**, with the help of coordinates.

Two Types of CRS:

- **Geographic** Coordinate System: Latitude / Longitude
- **Projected** Coordinate System: X/Y values

Ellipsoid:-

a flattened three-dimensional ellipse with smooth surface to approximate the earth



Ellipsoid:-

a flattened three-dimensional ellipse with smooth surface to approximate the earth

Typically, an ellipsoid has its own specific parameters, such as, **semi-major axis** (a in meters), **semi-minor axis** (b in meters), and **inverse flattening** (1/f =a/(a-b)).

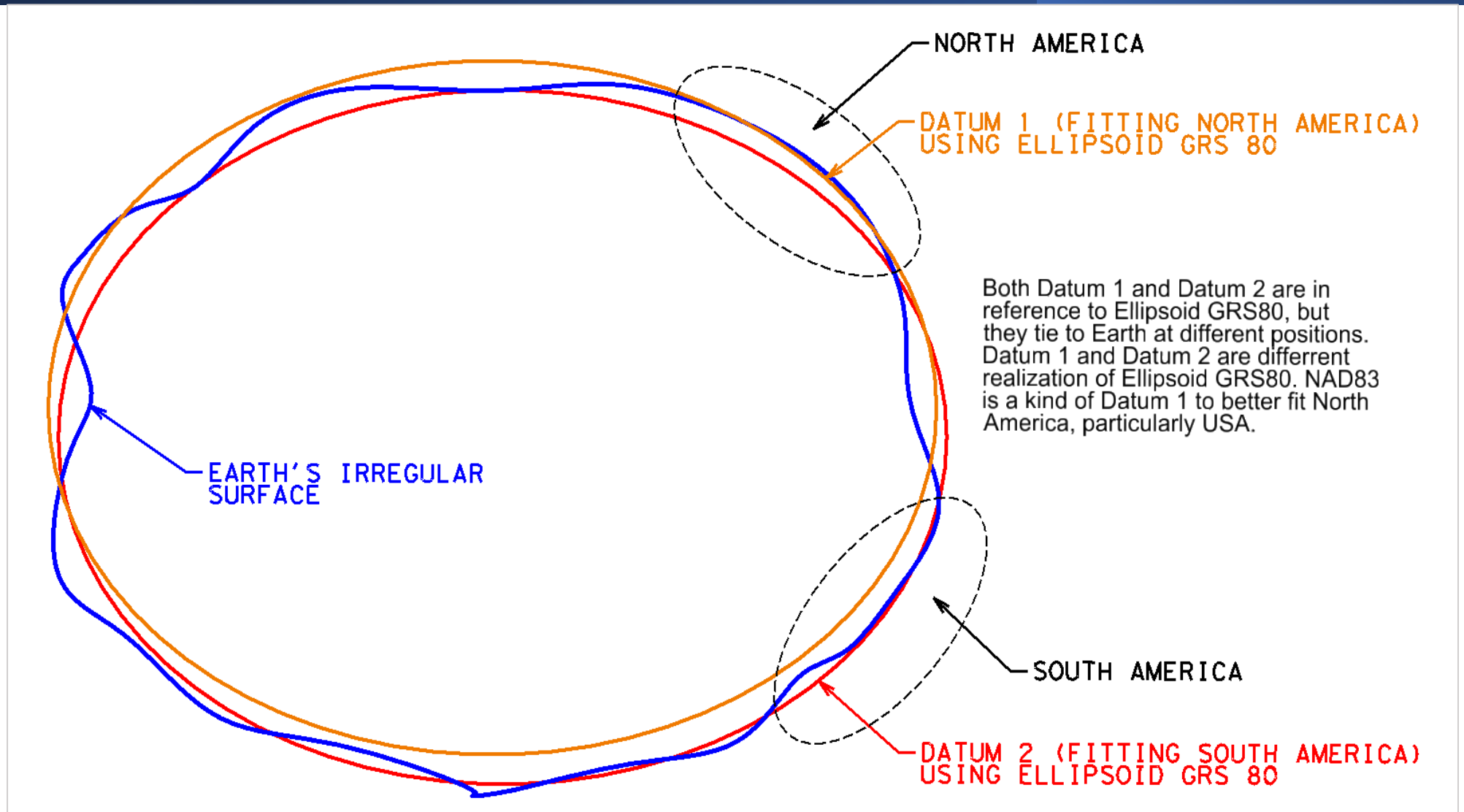
Ellipsoid	Semi-Major Axis a (m)	Semi-Minor Axis b (m)	Inverse Flattening 1/f
GRS80	6378137.000	6356752.314140356	298.257222101
WGS84	6378137.000	6356752.314245179	298.257223563
International 1924	6378388.000	6356911.946	297.000
Clarke 1880 (RGS)	6378249.145	6356514.870	293.465

Datum:-
a model of the shape of the earth

- An ellipsoid has different realizations, which are different **ways to position itself relative to Earth depending on where its center is located**.
- **Each realization is called a datum** and therefore an ellipsoid may have different datums.
- Simply, a Datum is **a model of the shape of the earth** per se.
- Typical datum: **WGS84** (the name is same as its ellipsoid); **ED50** (its ellipsoid: International 1924/Hayford); **Nord Sahara** (its ellipsoid: Clarke 1880 RGS).

Datum:-

a model of the shape of the earth



Fun Fact -

Lat/Long values of a physical location differ from Datum to Datum.

Since longitude and latitude values are tied with datums, **a location's longitude and latitude values in reference to Datum WGS84 are not same as in reference to Datum NAD83, nor Datum ED50.**

City	WGS84		NAD83	
	Latitude	Longitude	Latitude	Longitude
Calgary, AB	51°02'55.0140"	-114°04'15.0456"	51°02'55.0045"	-114°04'15.0608"
St Louis, MO	38°37'37.211"	-90°11'57.847"	38°37'37.185"	-90°11'57.825"
Houston, TX	29°44'59.665"	-95°21'30.316"	29°44'59.646"	-95°21'30.290"
Pasadena, CA	34°09'22.007"	-118°07'54.995"	34°09'22.007"	-118°07'54.951"

Projection:-

the means by which you display the coordinate system and your data on a flat surface.

Mathematical calculations are used to convert the coordinate system used on the curved surface of earth to one for a flat surface.

A 3D element will lose at least one of its three characteristics – angle, area, and distance when being projected onto 2D surface, NO MATTER which projection method is used.

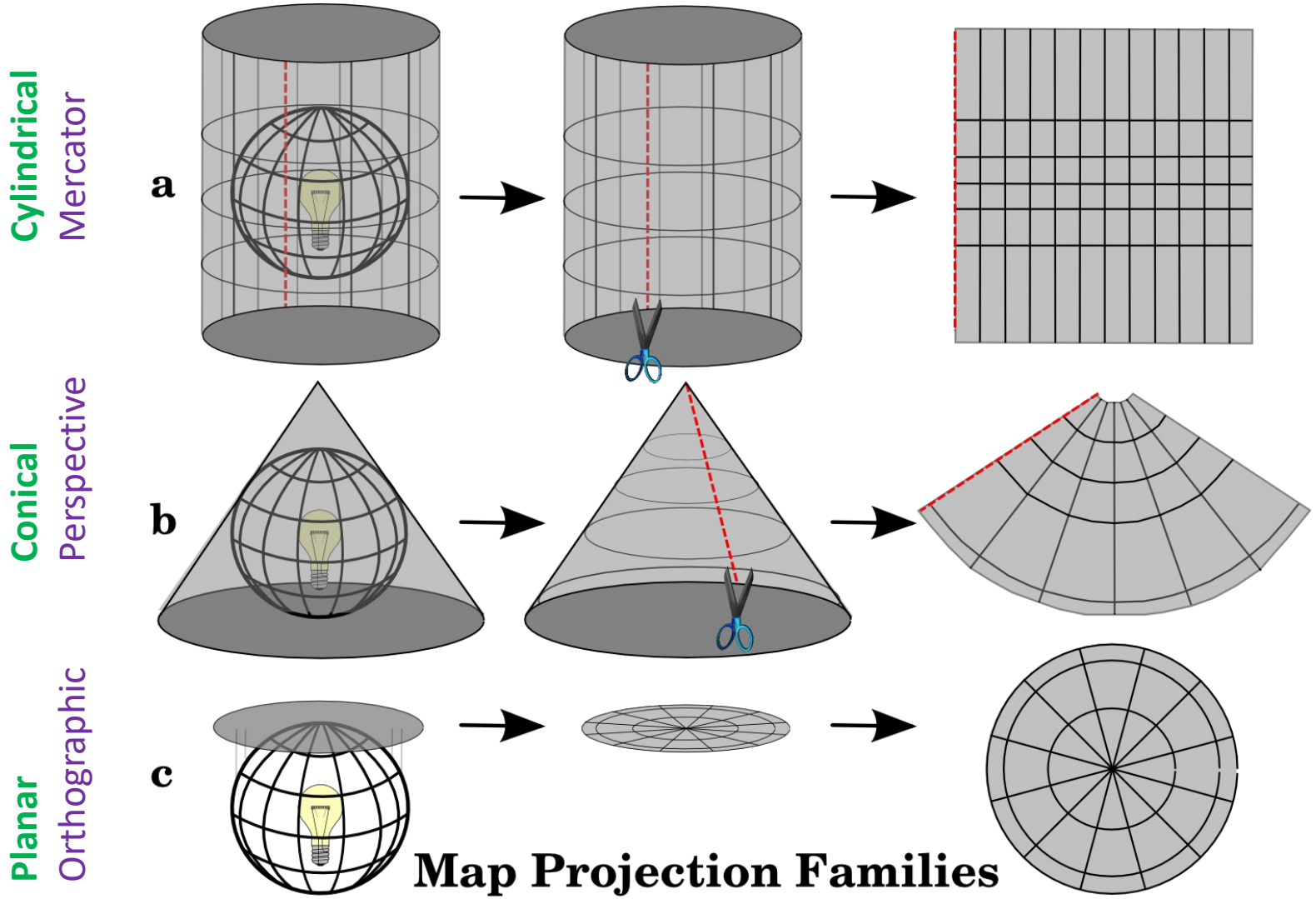
The coordinate system on 2D surface is called a Projected Coordinate System (“PCS”) with coordinate unit of foot, US foot, or meter.

Projection:-

3 Types of Projection Methods: Cylindrical, Conical, and Planar

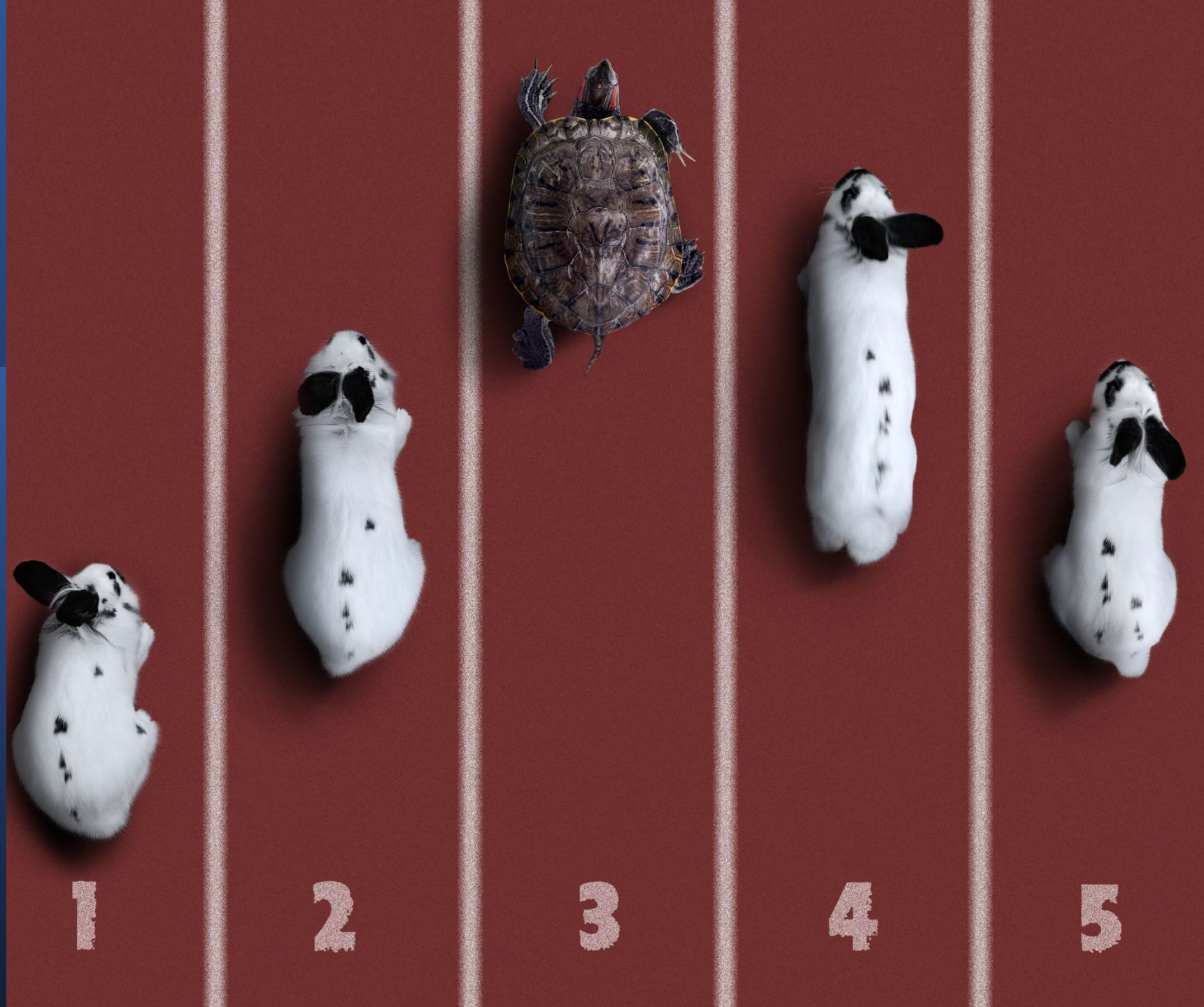
Universal Transverse Mercator ➔

Lambert Conformal Conic ➔

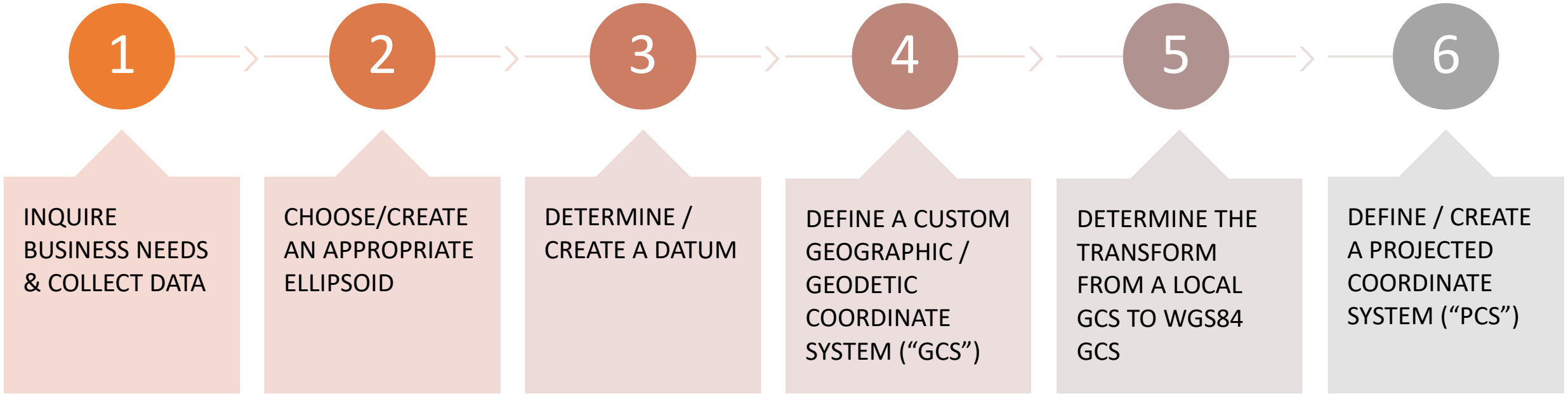


How to Create Custom CRS in

IHS-Markit Kingdom 2021/2017



Procedures to Create a Custom CRS in Any Application



(1) Inquire Business Needs & Collect Data

AGOCO Lambert Datum Using 2 Parallels	
Ellipsoid	Clarke 1880
Projection	Lambert Conical Orthomorphic
Latitude of Origin	31° N
Longitude of Origin	18° E
Scale Factor @ the Origin	0.99938949
First Parallel	33° 00' 00''
Second Parallel	28° 59' 08.3''
False Northing	550,000m
False Easting	1,000,000m
Semi Major Axis	6,378,249.145m
Reciprocal Flattening (1/f)	296.465
Central Meridian	18° E
Zone	Libya North

1. A 3D Seismic cube of Concession NC-100 of west Libya has a projection of Lambert Conformal Conic ("LCC"), instead of the commonly used UTM Projection, and AGOCO-cooked Datum based on Clarke 1880 Ellipsoid.

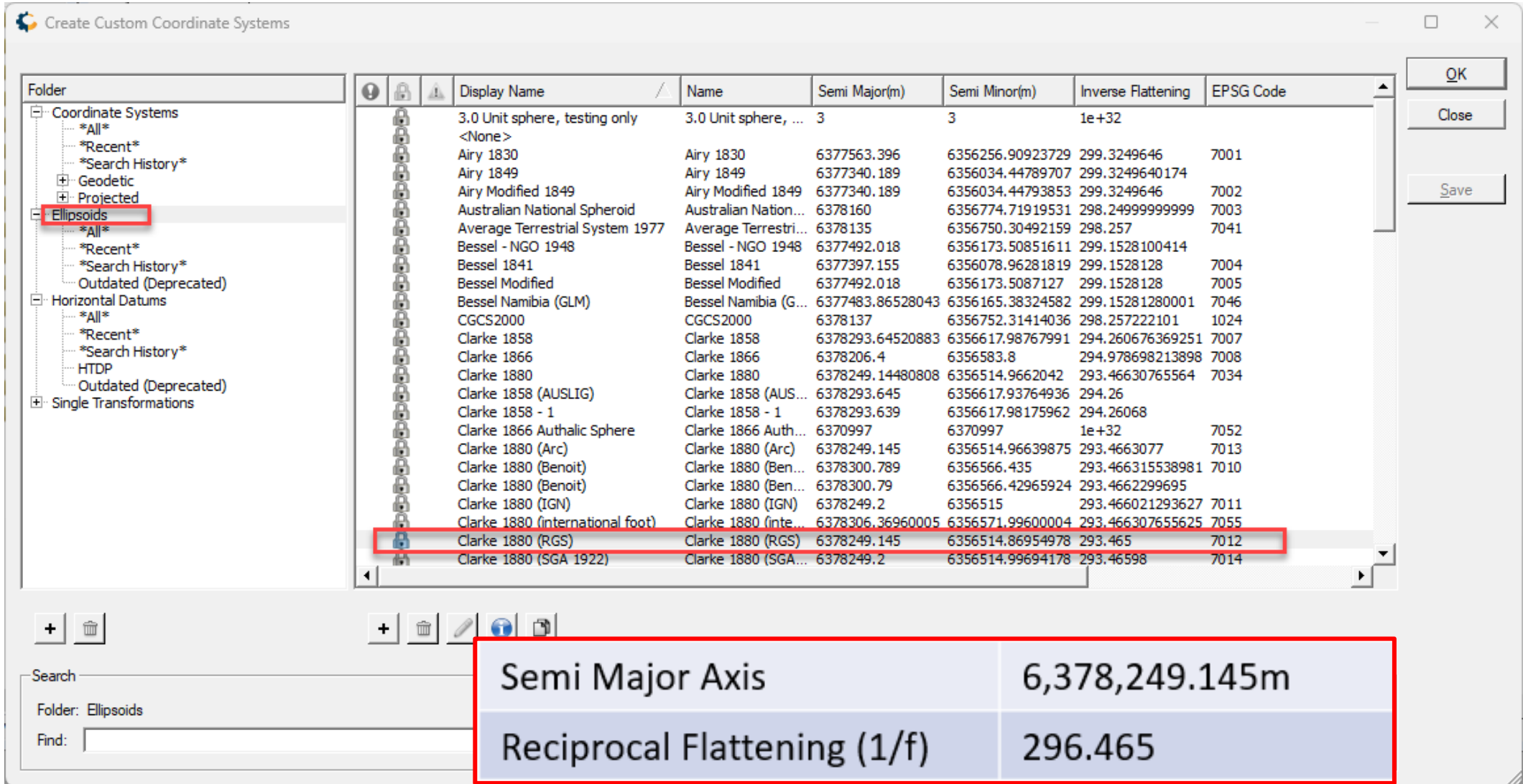
2. Failed to load the seismic cube into Kingdom or Petrel due to lack of pre-defined Projected CRS related to that specific cube.

3. Plan to create a Custom Projected CRS ("PCRS") and Transform for converting or loading up such seismic cube into Kingdom 2021/2017.

(2) Choose/Create an Appropriate Ellipsoid

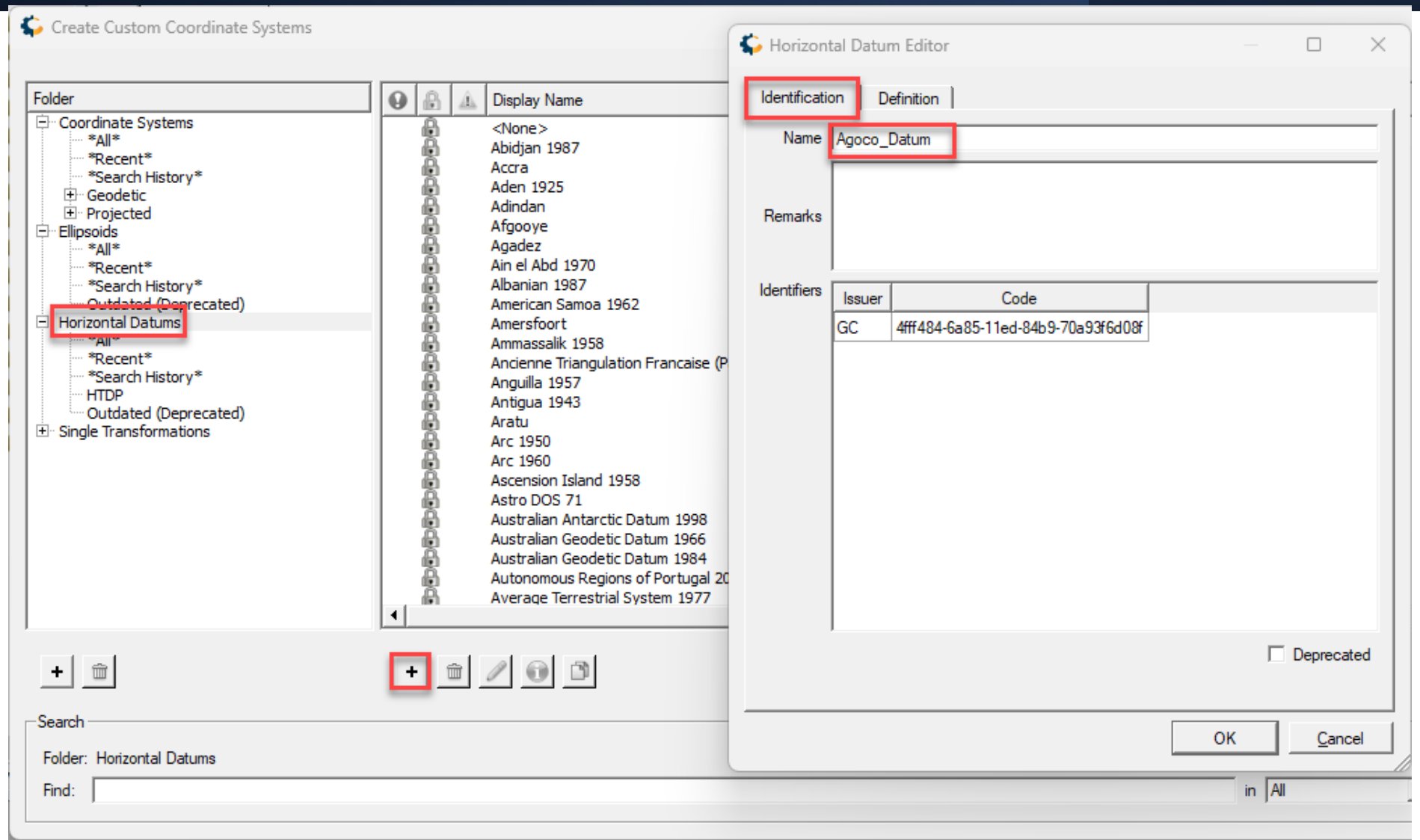
Launch Kingdom 2021 → ”Project” → “Projections” → “Create” button

Open “Folder”, then “Ellipsoids”; Comparing the ellipsoid params from AGOCO (“Clarke 1880”) and the ellipsoid params in the table, then we shall choose “Clarke 1880 (RGS)” as our ellipsoid (EPSG:7012).



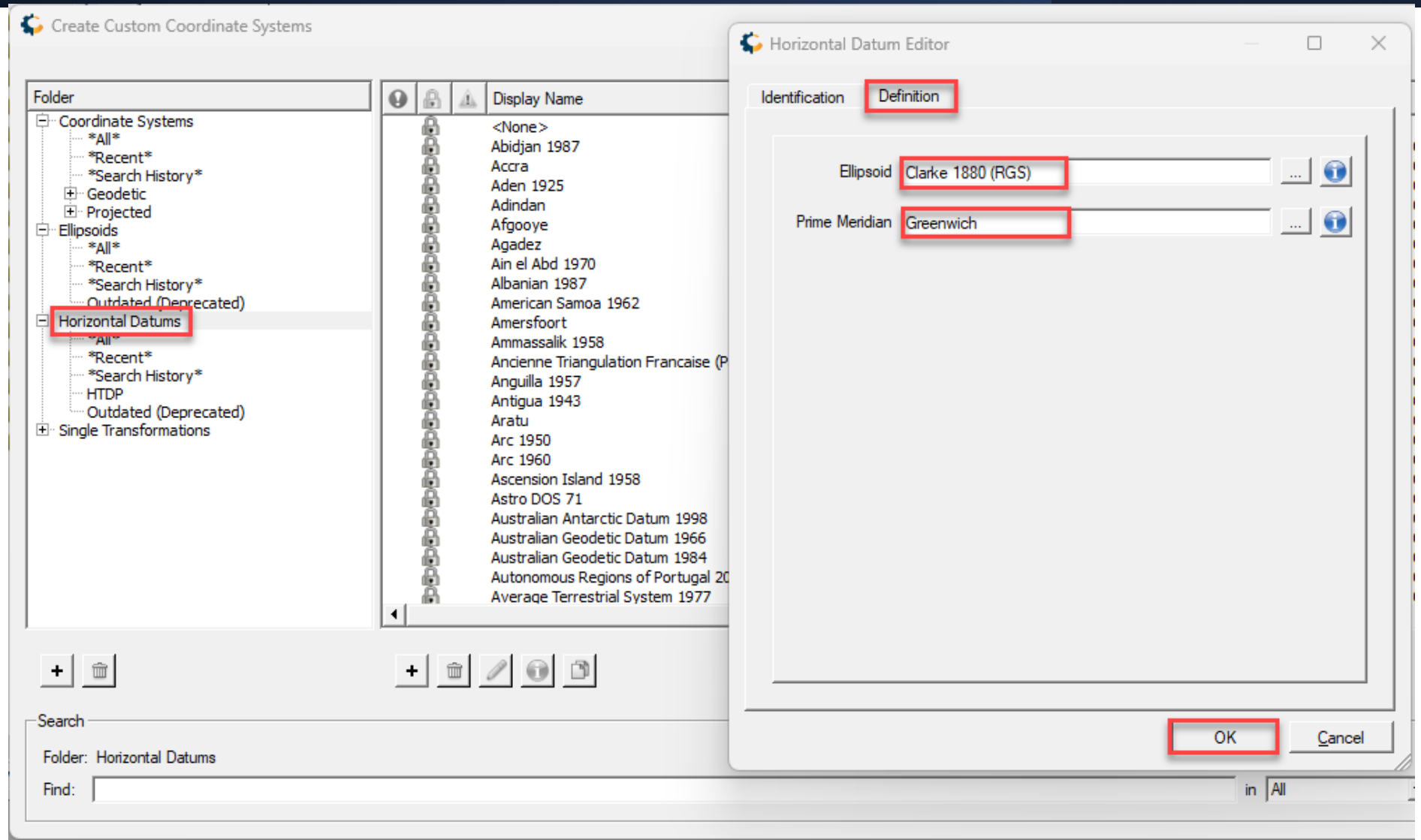
(3A) Determine/Create a Custom Datum

Horizontal Datums → Click "+" sign → Name it as "Agoco_Datum" at "Identification" tab



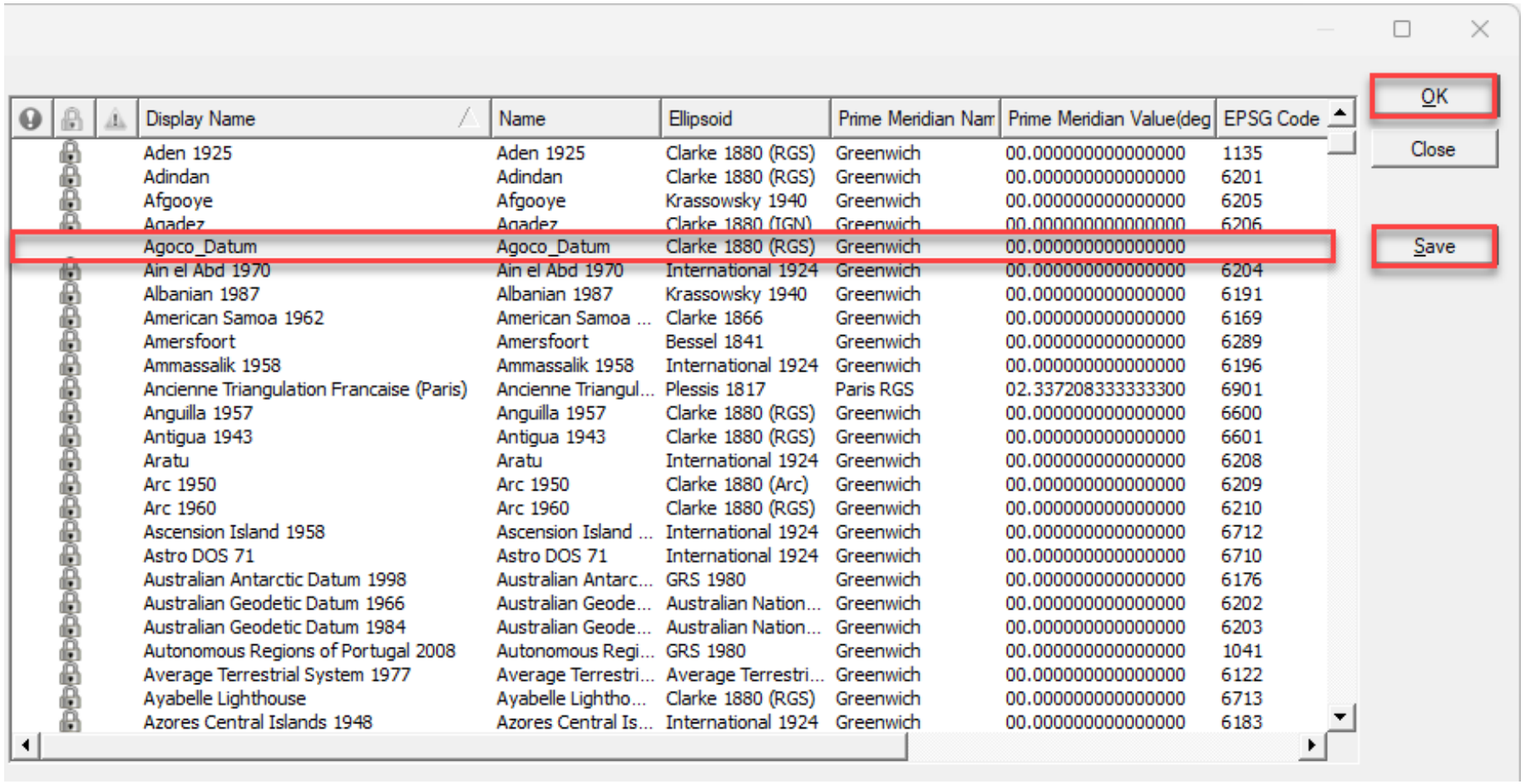
(3B) Determine/Create a Custom Datum

Switch to “Definition” tab → Pick up “Clarke 1880 (RGS)” as Ellipsoid and “Greenwich” as Prime Meridian → Click “Ok” to save the selections and return.



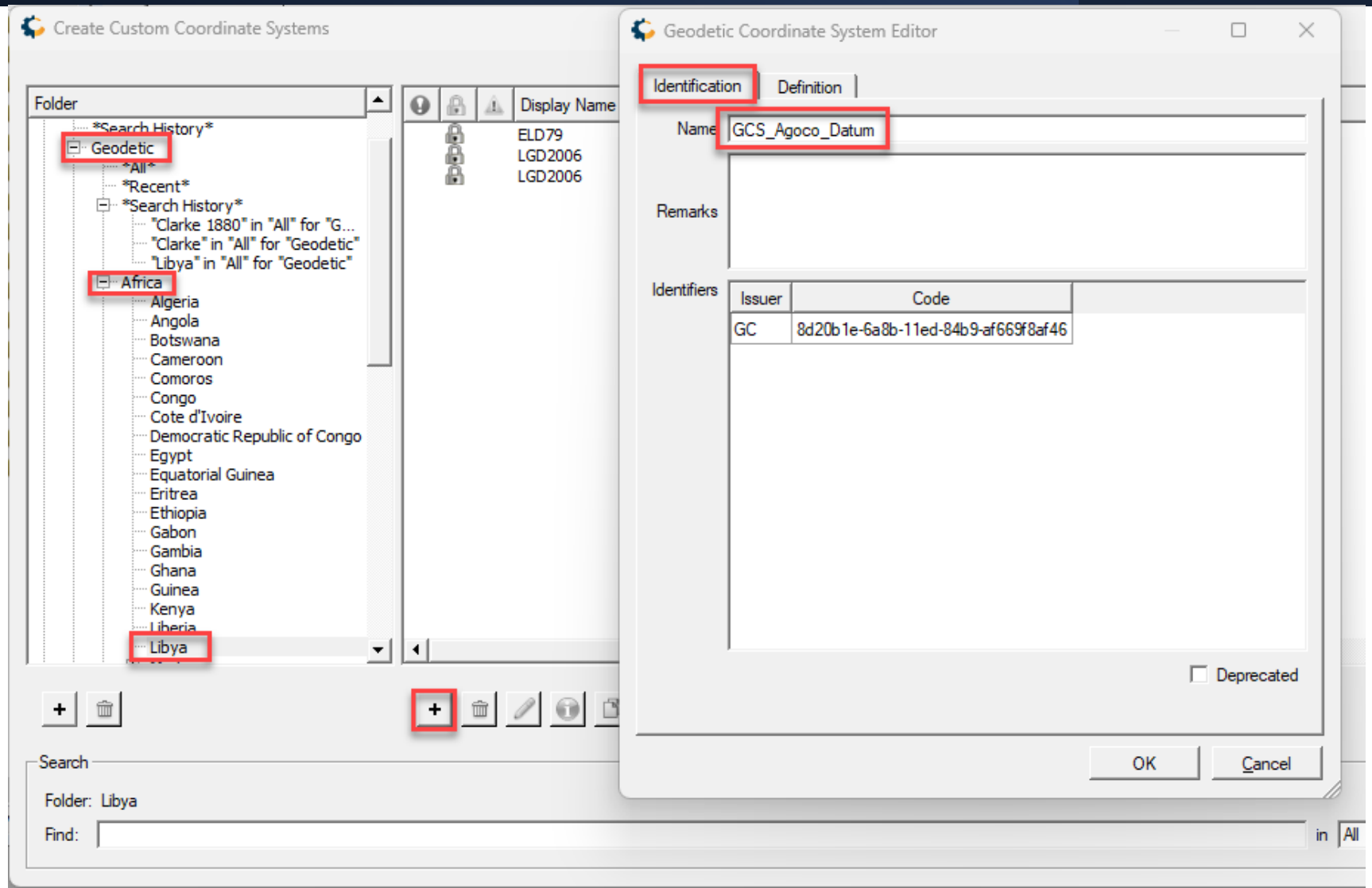
(3C) Determine/Create a Custom Datum

Check the new Datum is listed in place → Click “Save” button to save the custom Datum.



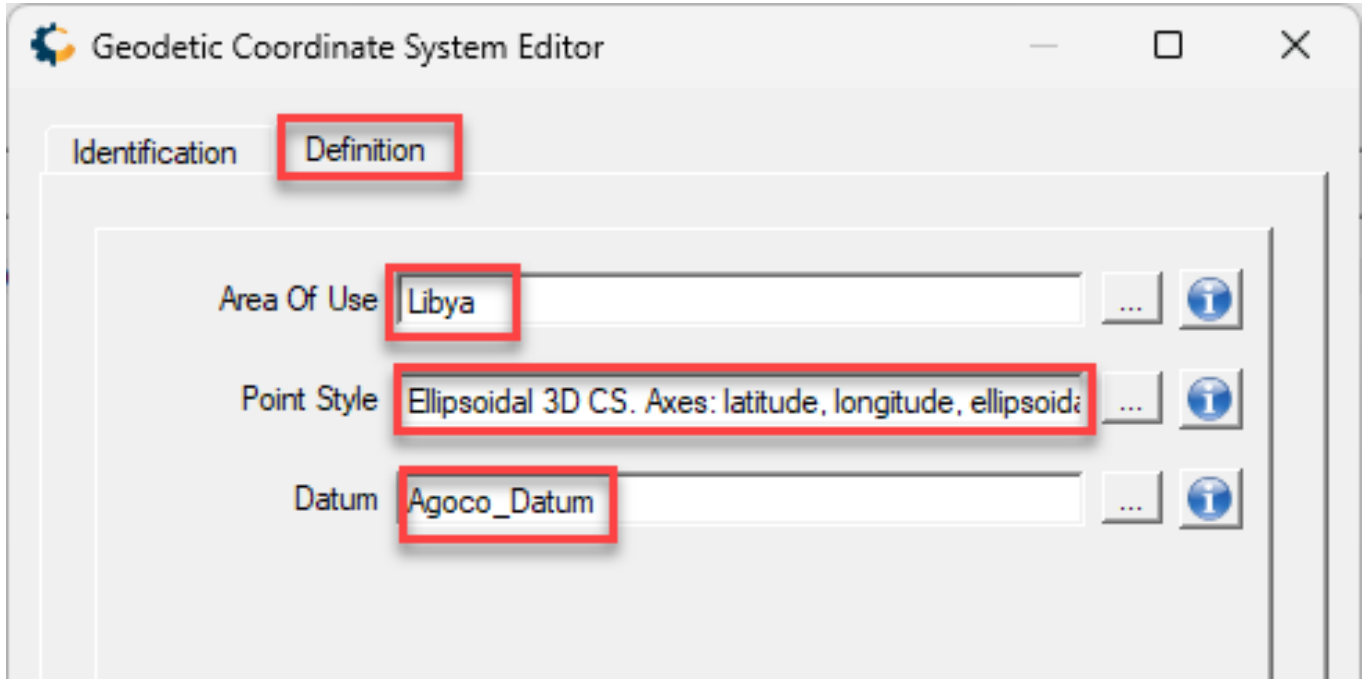
(4A) Define a Custom Geodetic Coordinate System (“GCS”)

Expand “Geodetic”, “Africa”, “Libya” → Click “+” sign → Name the Geodetic CS as “GCS_Agoco_Datum” at “Identification” tab.



(4B) Define a Custom Geodetic Coordinate System (“GCS”)

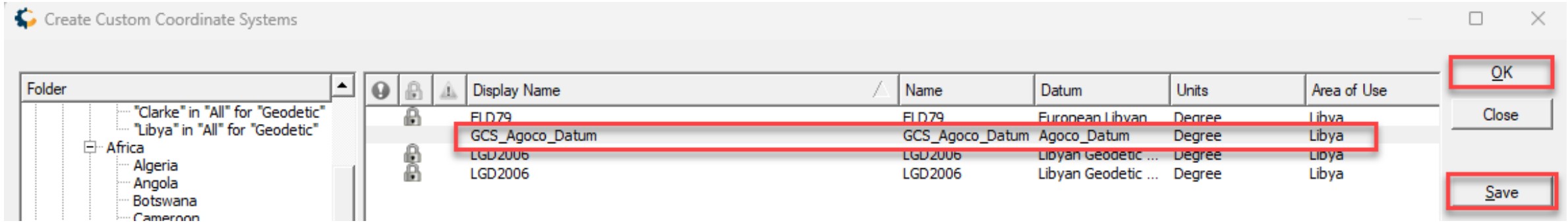
Switch to “Definition” tab → Pick up “Libya” as Area of Use, “Ellipsoidal 3D CS” as Point Style and the Custom “Agoco_Datum” as Datum. Then return to the main window to click “save” and “OK” buttons.



Please note: the Ellipsoidal CS Point system shall bear an EPSG code: 6422 (2D) or 6423 (3D).

EPSG 6422/6424 is a 2D geographic Point System and it’s good for most of the cases.

EPSG 6423/6426 is a 3D geographic Point System, bearing the ability for Vertical Datum transform, which is a very rare case though;



(5) Determine the transform from a local GCS to WGS84 GCS

Every built-in or custom Geographic Coordinate System (“GCS”) can be functional ONLY through the “Hub” of all Coordinate Systems – the WGS84.

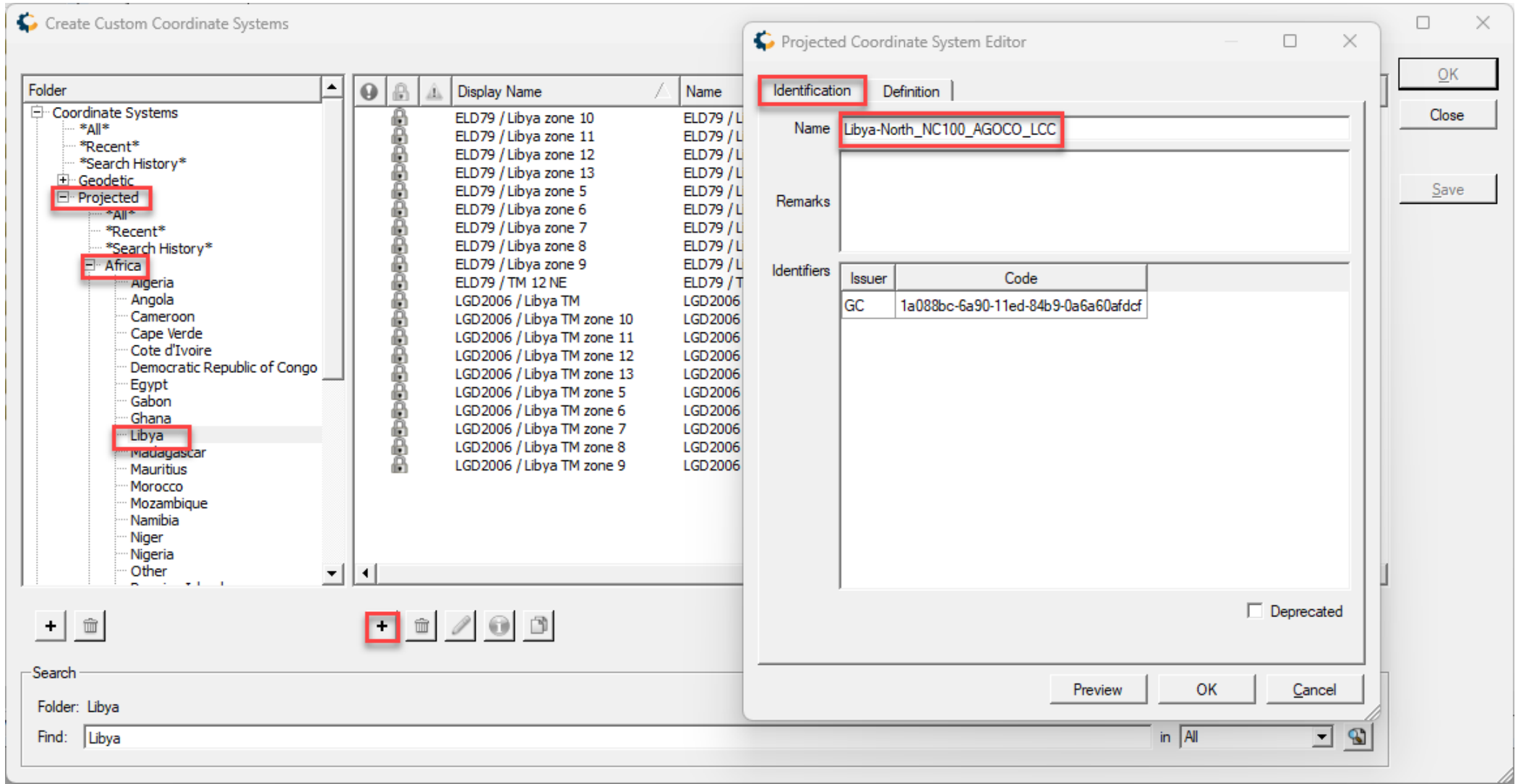
In ArcGIS, Blue Marble Geographics, Petrel and other applications, the transform parameters (3-param or 7-param method) must be specified explicitly.

IHS Kingdom has a black-box mechanism to transform the Custom GCS to WGS84 GCS as far as the former is based upon any built-in ellipsoid (and it has to be that way). That’s why Kingdom works very well with the build-in ellipsoid and its derived datums.

Since our Custom Datum is based on “Clarke 1880 (RGS)”, the transform is to be taken care of by Kingdom behind the scene.

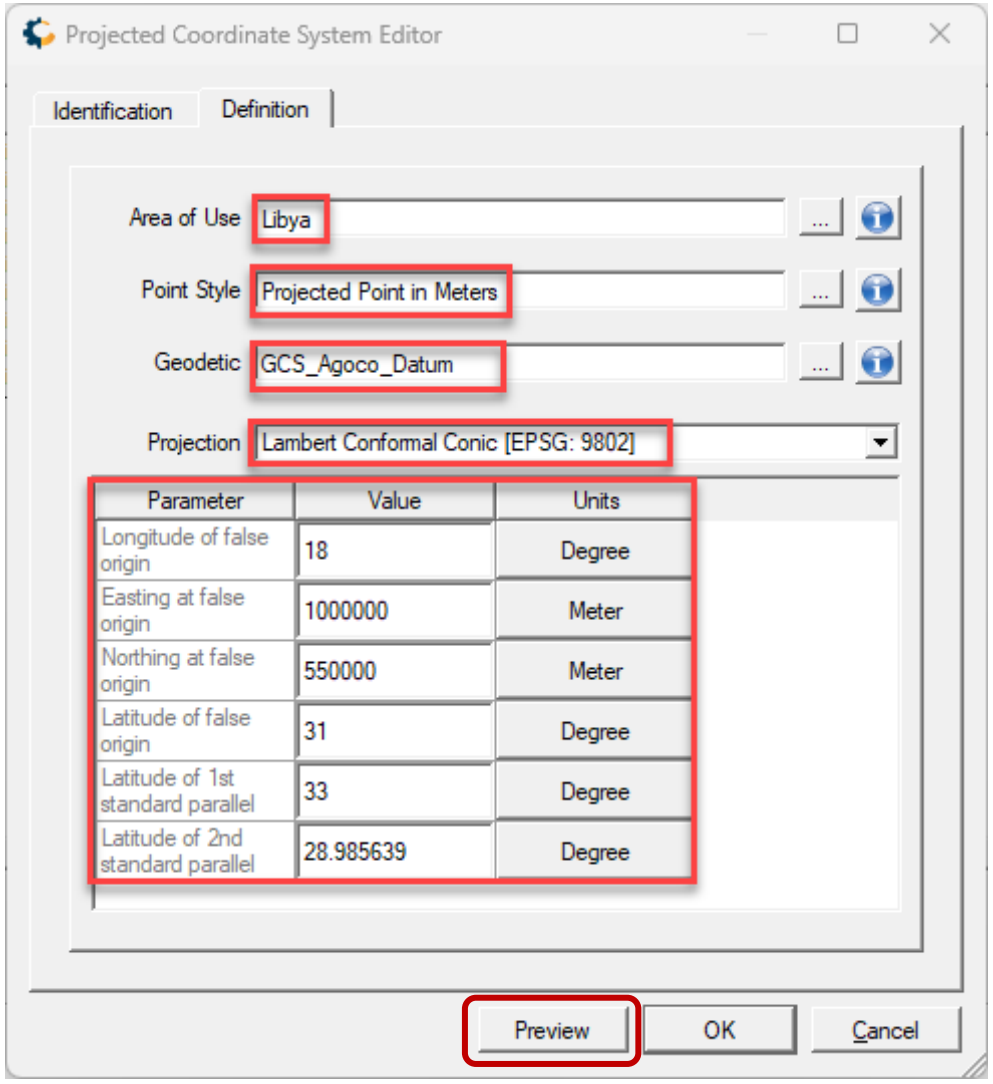
(6A) Define / Create a Projected Coordinate System (“PCS”)

Expand “Projected” > “Africa” > “Libya” → Click “+” sign → at “Identification” tab: Name the Projected CS as “Libya-North_NC100_AGOCO_LCC” or anything you like.



(6B) Define / Create a Projected Coordinate System (“PCS”)

Switch to “Definition” tab → Pick up “Libya” as Area of Use, “Projected Point in Meters (EPSG: 4461)” as Point Style, the custom “GCS_Agoco_Datum” as Geodetic, “Lambert Conformal Conic [EPSG: 9802]” as Projection, then fill in the table.

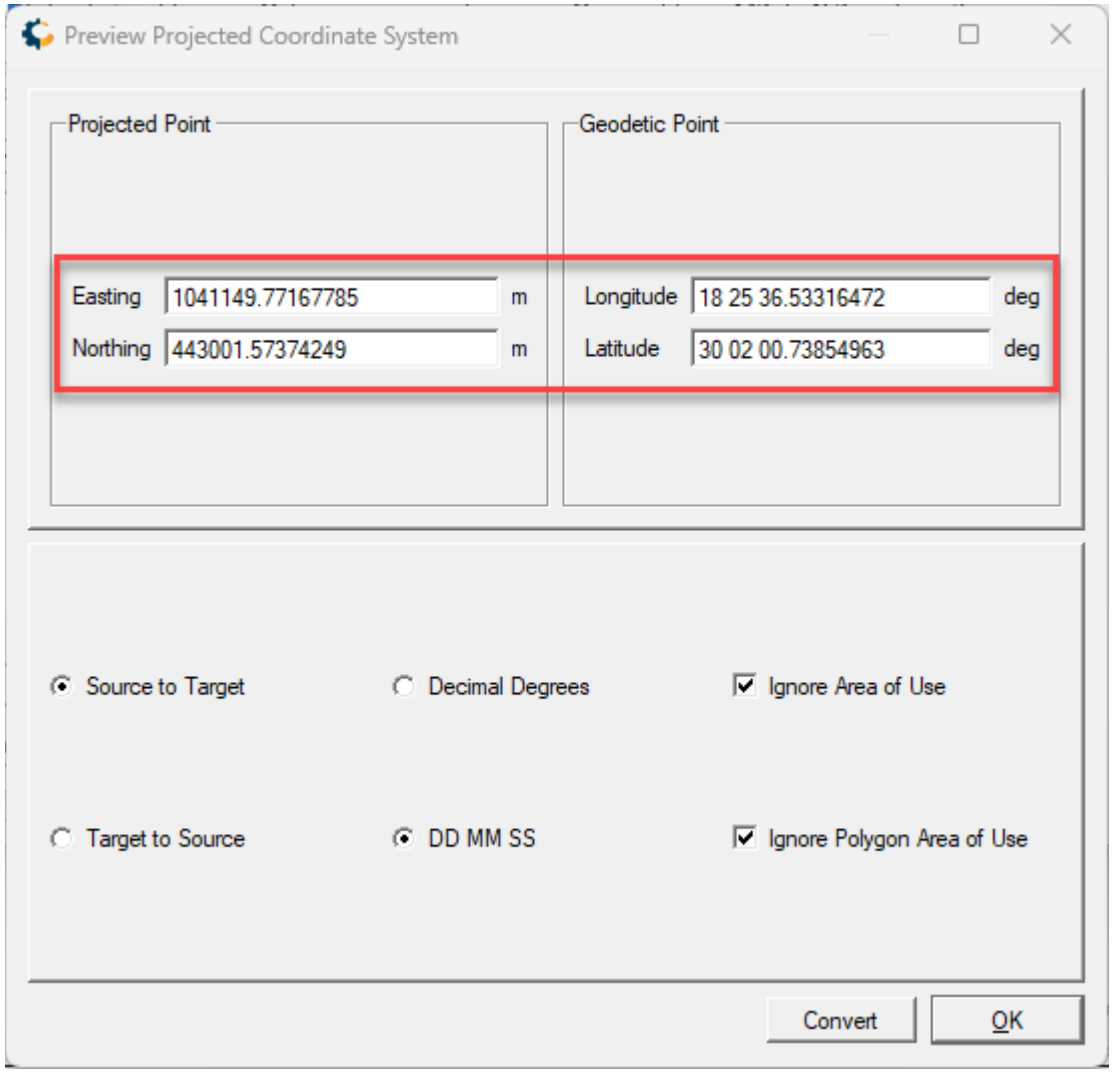


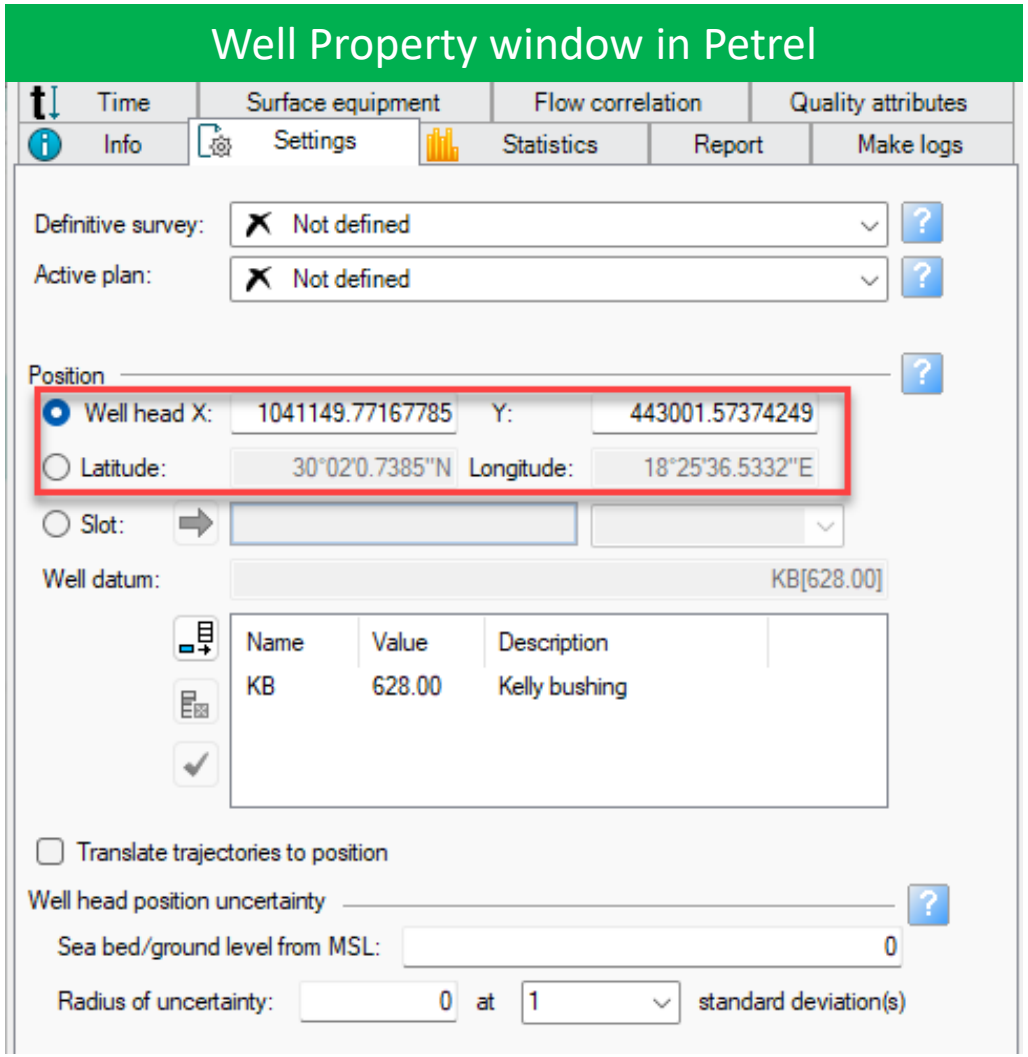
For the Projection Method, you can pick up “Lambert Conformal Conic [EPSG: 9801]”, which is for the 1-standard-parallel LCC (tangent). That does not fall into our case.

Click “Preview” button to take a look into how good your custom Projected CRS is. The details are demonstrated in next slide.

(6C) Define / Create a Projected Coordinate System (“PCS”)

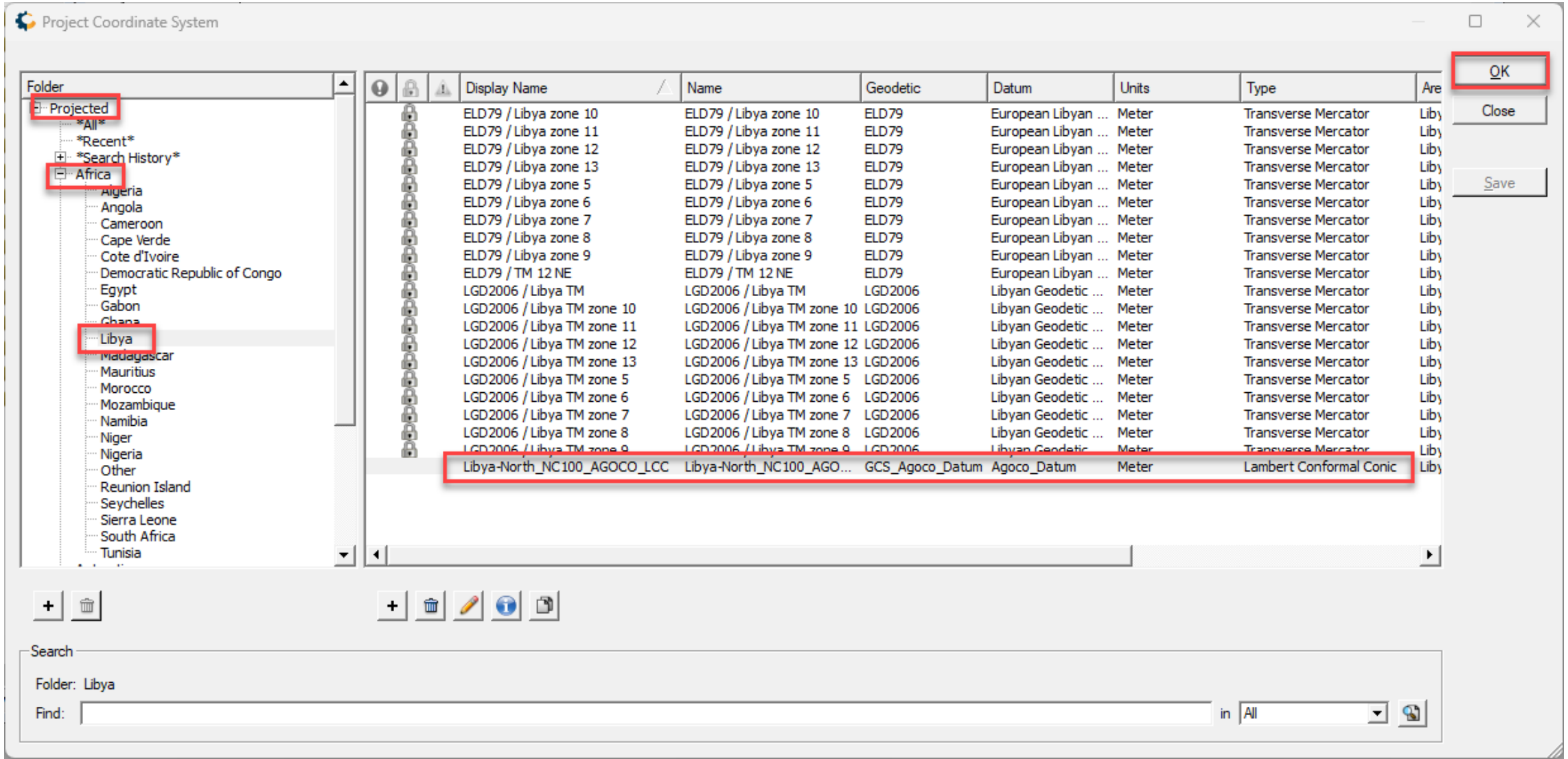
The results at Preview window (Left) demonstrates a very precise conversion versus the results from Petrel (Right).
Then return to the main window, click “Save” and “Ok” button to save everything.





Lastly set the Projected CRS for the project

Launch Kingdom 2021 → Click “Project” > “Projections” > “Set” and select “Libya-North_NC100_AGOCO_LCC”.



Conclusions: Custom CRS is Doable/Applicable in Kingdom

Application / Version	Able to Customize Coordinate System?
Kingdom 2021	Yes, tested Okay, results verified against Petrel/ArcGIS.
Kingdom 2017	Yes, tested Okay, results verified against Petrel/ArcGIS.
Kingdom 8.8	Yes, tested Okay.

Note: Coordinate Reference System (“CRS”) and Coordinate System (“CS”) are interchangeably used in line with the industry practice.

The End

References	
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ArcGIS website	www.arcgis.com
Blue Marble Geographics	www.bluemarblegeo.com
Wikipedia	www.wikipedia.org
Schlumberger Ltd.	Petrel Help and Manual, 2018-2021
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